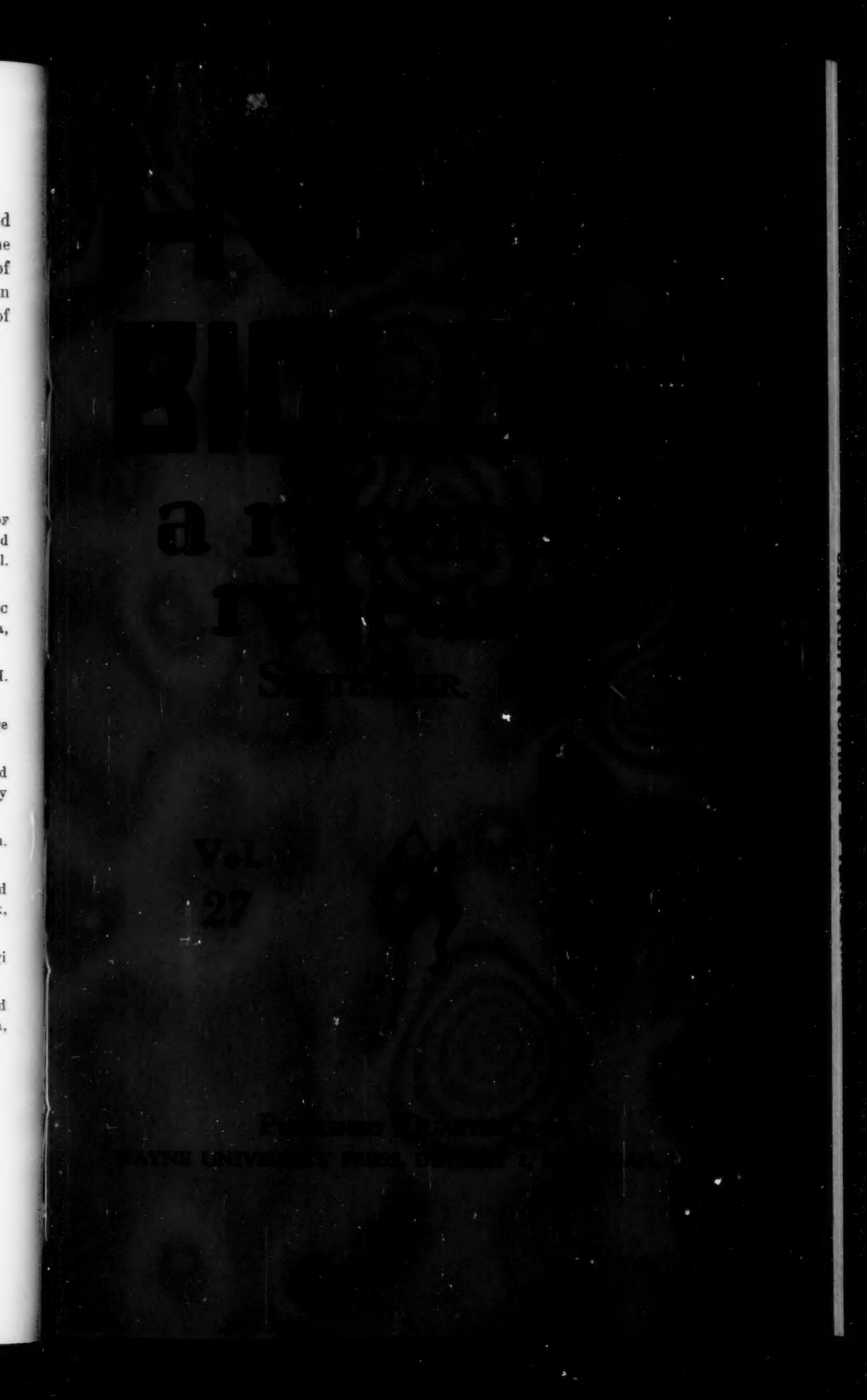

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TASTE SENSITIVITY TO PHENYLTHIOUREA IN SPANIARDS

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INTRDUCTION

AS is well known, phenylthiourea (P.T.C.) is a substance having a bitter taste. In 1932 Fox demonstrated notable individual differences in taste sensibility using this substance and many experiments using various methods have since been performed about the matter. Some authors use very simple techniques: for example, tasting of a simple aqueous solution or impregnated paper, or simply by putting pieces of crystal on the tongue.

Other investigators use more complex methods such as the use of a series of dilutions to determine the concentration threshold for each person. When this method is used it is seen that a simple classification into tasters and non-tasters is a reflection of an essentially bimodal distribution of taste thresholds and that the antimode can be taken as a

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ruler to differentiate the two categories. The dilution at which this antimodal minimum frequency occurs varies from population to population; methods which fail to take thresholds into account are subject to errors on this account. On the other hand, the subjective nature of the answers leads to errors which are difficult to control when the simpler methods are used, as well as, the latter one.

The method of Harris and Kalmus ('49), in which the subject is required to perform a sorting test, is an indubitable advancement for it permits a more objective determination of the threshold concentration. In this method we start with a stock solution of 0.13% and from it obtain a series of 14 solutions each with ½ the concentration of the previous solution. We used boiled tap water for these.

The test is performed in two stages. First, we determine the approximate value of the threshold by giving the subject a few cc of the solutions, beginning with the most dilute, until he perceives a definite taste. Secondly, we proceed to a more exact determination of the threshold by means of a sorting test. For this we give the subject 8 glasses, 4 having a few cc of water and the other 4 a few cc of the solution which has already been determined in the first stage of the test. The glasses are arranged at random and the subject is told that 4 of them contain the substance and 4 contain water; he is asked to separate them into the two groups. If he succeeds, we make him try with the next weaker solution and so on until he is unable to differentiate one of the solutions from water. If he is not able to establish the difference with the first solution, we do the same thing but follow an inverse order, using solutions of increasing concentration.

We believe that at present this Harris-Kalmus technique gives the most objective results. In the course of our studies we have verified that some suggestible individuals who, in the end, proved to be non-tasters would have been classified as tasters had we followed their first subjective reactions and not done the sorting test. Furthermore, we have also tried the method of impregnated papers which are sold for this purpose and have found that the results are not always satisfactory. Apart from giving some wrong classifications, we sometimes got different answers for the same individual using different papers of the same origin—probably because the papers are not uniformly treated.

MATERIAL

The sample consists of 306 individuals: 203 males and 103 females. The majority are students or teachers at the University of Barcelona and the rest (13%) are otherwise employed. More than 85% of the individuals come from the northeastern provinces of Spain. Considering that the predominant racial element there is the Mediterranean, we venture to assert that this element is the most frequent one in our series. The sample is drawn from a large city, representative of the genotypic complex of the people of northeastern Spain; therefore, the sample does not correspond to a limited geographical breeding group.

It can be seen from the age distributions in tables 1 and 2 that the

TABLE 1

Taste thresholds for P.T.C. in Spaniards ♂

Age in years	Solutions															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
6–7												1				1
8–9																
10–11																
12–13	1									1						2
14–15									1							1
16–17	4	2	1	1			2	2	6	8	9	5	1		1	42
18–19	2	6	4	3		1		4	11	21	8	3	1			64
20–21		2	1		1	1			2	3	6	1				17
22–23		2				1		1		4	3	2	1			14
24–25		2	2		1			1		4	3					13
26–27	2	1	2					1		2	1	2				11
28–29	2										2	1	1			6
30–31					1				1	1	1	3				7
32–33	1				1			1	2	4	2					11
34–35		1			1			1		1		1	1			6
36–37											2					2
38–39																
40–41		1														1
42–43			1													1
44–45									1							1
46–47											1					1
54–55										1						1
74–75										1						1
Total	12	17	11	4	5	3	2	11	24	51	38	19	5		1	203

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majority of subjects were fairly evenly distributed within the age range 16–37 years. The mean age is 22.3 years for the males and 24.0 years for the females. The threshold values in these tables were determined exactly as indicated by Harris and Kalmus.

TABLE 2

Taste thresholds for P. T. C. in Spaniards ♀

Age in years	Solutions															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
10–11											1					1
12–13																
14–15											1					1
16–17		3							1	2	3	1				10
18–19		4		1	1			2	1	7	4	2	3			25
20–21		1	1					1	1	2	4	5				15
22–23	2		1	1					1	5	3	1		3		17
24–25									1	1	1		1			4
26–27		1								1	1					3
28–29	3		1		1						1	1	2		1	10
30–31											3					3
32–33		1								1						2
34–35										1	1					2
36–37										1						1
38–39											1		1			2
40–41			1								1	1				3
42–43										1						1
44–45																
46–47															1	1
54–55	1															1
64–65										1						1
Total	6	10	4	2	2			3	5	23	25	11	7	3	2	103

RESULTS

Sensibility thresholds

Sexual dimorphism. Considering that the mean age of both series and the distribution of frequencies at different ages are similar, the masculine series can be compared directly with the feminine one. The average taste threshold for males is 7.33 and for females, 7.98. That is, the average taste sensitivity is greater in women than in men which accords with results given by other investigators working on other populations.

Apart from the above considerations, the two distributions (see figure 1) were compared using the χ^2 test; the difference is slightly high but not statistically significant ($\chi^2 = 16.59$; probability differential laying between 90% and 95% for 10 degrees of freedom). Classes 4, 5, 6 and 12, 13, 14 were merged for the χ^2 calculation.

Influence of age. Harris and Kalmus ('49) in their studies on English people and Mohr ('51-'52) on Danish, found that taste capacity to phenylthiourea decreases with age. To study this we have combined the masculine and feminine series; as noted above, the age distribution in the two sexes is alike.

Our series is chiefly comprised of first year university students. For this reason we can only give few data on older individuals. The results are as follows:

Age	n	Mean threshold
x–19	147	7.44
20–39	146	7.69
40–x	13	7.23

From these we can see that taste capacity does not decrease up to the age of 40. From that age on, the small number of data does not permit any conclusion.

Influence of tobacco. It has been said that use of tobacco might decrease the capacity to taste phenylthiourea. To check this in Spaniards we questioned the individuals here analysed concerning their use of tobacco. If they answered affirmatively we asked them the average number of cigarettes they smoked daily. As women in Spain are generally non-smokers, we dispensed with the feminine series and based this study on the masculine series.

There were 97 male non-smokers and 75 individuals who smoked at least 5 cigarettes daily. The average threshold of the former is 7.38 and of the latter, 7.39. This verifies, by a different technique, the conclusion of Falconer ('47) that tobacco does not seem to influence this taste capacity. Furthermore, a subseries of 52 individuals who smoked 10 or more cigarettes daily was elaborated for greater sureness. The taste threshold average is 7.52, that is, even slightly higher than non-smokers.

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Frequency of non-tasters

As there is no apparent variation of taste sensibility with age in the ages covered in this series, one can dispense with the subdivision into age groups and use the total series for the determination of the antimode.

For the males it seems convenient to separate the tasters from non-tasters between classes 5 and 6. For the females there is no problem; the distribution is discontinuous and there are no cases in classes 5 and 6. Futhermore, for both series combined, the division at a limit between classes 5 and 6 seems still most reasonable. The same would be true if an antimode were established for each age group separately.

Dividing the series at this limit we obtained the following frequencies:

	Non-tasters	Tasters	Total	% non-tasters	Standard error
Male	52	151	203	25.6	± 3.1
Female	24	79	103	23.3	± 4.2
Total	76	230	306	24.8	± 2.5

The frequency of non-tasters is greater in the males, but the difference is not statistically significant ($\chi^2 = 0.196$ for one degree of freedom).

The proportion of non-tasters was also calculated according to smoking habits. The differences are very small: non-smokers, 24.7%; smokers (at least 5 cigarettes daily), 25.3%; and heavy smokers (10 or more cigarettes daily), 25.0%.

We have also attempted a comparison with other human groups. In the pertinent literature there are considerable data on the proportion of tasters and non-tasters in different populations. Much of this was collected by other techniques, however, and, as we have already indicated, comparisons between populations may not be meaningful under such circumstances. For this reason we shall here limit comparisons to data obtained by the Harris and Kalmus technique.

In table 3 we give data for different populations following an increasing order of non-tasters. This permits one easily to see the contrast between the European populations proper, with frequencies of non-tasters of 25% to 32%, and African Negroes and Chinese and also the Lapps, with much lower frequencies.

TABLE 3

Frequencies of non-tasters in different populations using serial dilutions with sorting test

Population	Number	% non-tasters	Authors
African Negroes	74 (71 ♂ + 3 ♀)	2.7	Barnicot ('50)
Norwegian Lapps	78	6.8	Allison and Nevanlinna ('52-'53)
Swedish Lapps	62	7.0	Allison and Nevanlinna ('52-'53)
Chinese	66 (55 ♂ + 11 ♀)	10.6	Barnicot ('50)
Spaniards	306 (203 ♂ + 103 ♀)	24.8	Pons (The present study)
Finns	202	29.2	Allison and Nevanlinna ('52-'53)
English	441 ♂	31.5	Harris and Kalmus ('49)
Danes	314 (194 ♂ + 120 ♀)	31.8	Mohr ('51-'52)

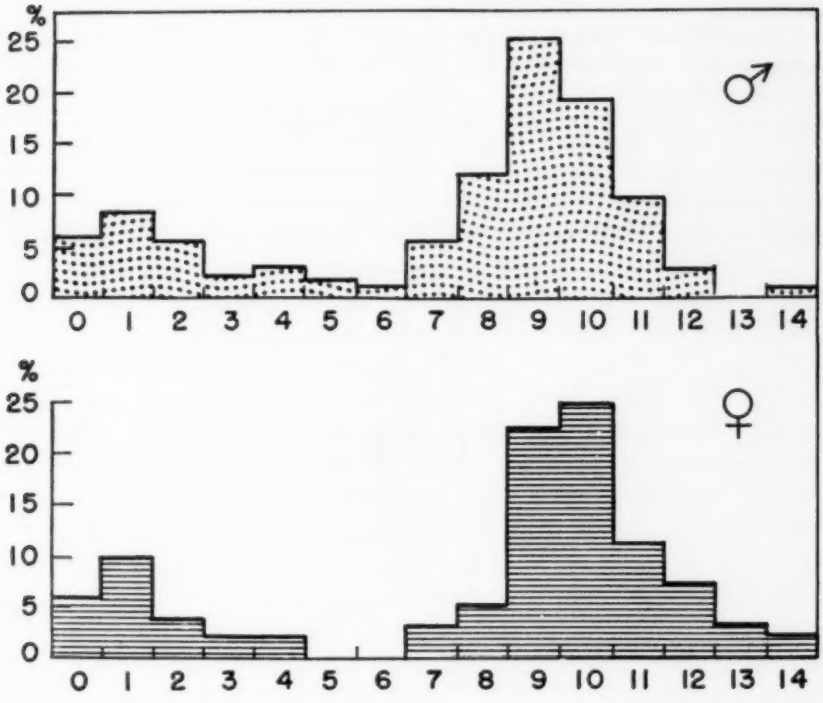

FIG. 1. DISTRIBUTION OF TASTE THRESHOLDS IN SPANIARDS.

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SUMMARY

Taste sensitivity to phenylthiourea was investigated in 306 Spaniards by the Harris and Kalmus technique. The average threshold is somewhat higher in females than in males. This is in agreement with earlier observations. Smoking does not reduce the capacity to taste phenylthiourea.

The frequency of non-tasters in Spaniards is 24.8%. A comparison of the present data with other populations so far investigated by the same technique shows that Europeans have high frequencies of non-tasters when compared with other populations.

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DEPOPULATION ON ULITHI

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INTRODUCTION

ULITHI Atoll, in common with most of the islands of the Caroline Archipelago, has experienced a severe decline in population since the early part of the century. It is my purpose to set down here some facts and figures to support certain opinions which I hold regarding the causes of this decline. Any contribution I may make will have to be a modest and tentative one, for the vital statistics and medical data necessary to construct an airtight case are not available. Nevertheless during a total of 9 months which I spent on Ulithi, distributed in two trips covering 1947-49, I made enough observations and collected enough census materials to convince me that my conclusions have much validity.

The atoll is located at 10° north of the equator at 139° east longitude. It is about 400 nautical miles southwest of Guam. The islands are composed of a coralline soil which supports only a limited variety of plant crops, particularly the coconut, taro, squash, sweet potato, and breadfruit. Fish contribute virtually the only item of flesh food. Social organization is based on matrilineal clans and lineages with patrilocal residence. There is almost no social stratification. Political control rests mostly in the hands of village councils which exercise their authority with wisdom and justice. Constant contacts of political and economic character are maintained with nearby islands, especially Yap, Ngulu, Fais, and Woleai. Most of the people are now Roman Catholics, having been converted since 1937, but there are many older people who still subscribe to a religion based on animistic beliefs, mild ancestor worship, and otiose deities. There is a strong belief in magic, both black and white. The people seem to be psychologically well adjusted, optimistic,

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and concrete, with an overwhelmingly group-oriented approach (Lessa and Spiegelman, '54).

There is a faint possibility that Ulithi was first discovered in 1525 by the Portuguese captain, Diego da Rocha. The evidence for this has with justice been disputed. Similarly doubtful is the often repeated assertion that the atoll was discovered in 1528 by the Spaniard, Alvaro de Saavedra, and that he remained there about a week. It is much more probable that the first to sight the island group was Ruy Gomez de Villalobos on January 23, 1543. While there is some argument that he may have seen Yap instead, there is no doubt that he visited some of the islands in the vicinity of Ulithi. Thus, it was probably the island of Fais, less than 40 miles to the east, where he found some natives who sailed out in boats and made the sign of the cross with their hands, saying in Spanish, "Good day, sailors!" This indicates that there had been a prior visitor in the area. Perhaps it was the aforementioned Diego da Rocha, for he seems to have been the first to discover Yap, on which he stayed for a while. But none of these voyages could have had an appreciable effect on the population of Ulithi, for either there was no more than fleeting contact or no contact at all. Moreover, the period involved was one in which venereal diseases had not gained great headway among Europeans.

There could have been more effect from "seven white men who wore pantaloons and stockings" and remained on the atoll, 5 of them marrying native women. These men were described by Olit, a boy who was one of a party of shipwrecked natives from Fais who landed in the Philippines in 1696 after 70 days at sea. There is no reason to suppose, however, that these settlers had anything to do with introducing factors making for depopulation. Other contacts, too, coming soon after, seem to have had little permanent effect. For example, the next visitor to Ulithi was Don Bernardo de Egui y Zabalaga, who arrived in 1712 and was involved in a disagreeable incident involving the wounding of some natives by musket fire. Egui had little time other than to antagonize the natives, whom he tells us were a "well-built race" and "very gay." Judging from the spirited opposition they put up when he attempted to abduct one of their number, they were not a demoralized people.

The next visitor to the islands stayed long enough to have left an imprint but it is doubtful if he or his party had any effect on population. Father Antonio Cantova had had a long and ardent desire to convert the natives, about whom he had learned in 1721 from some Carolinians

shipwrecked on Guam. He ultimately arrived on Ulithi on March 2, 1731, accompanied by another priest, 12 soldiers, 8 cabin boys, and a Carolinian. After three months the party ran out of food and the other priest was sent back to the Marianas for help. He was delayed by storms and did not return until 1733, when he found all of the group of the mission had been killed. From that time on Ulithi was generally avoided because of the reputation it had acquired through the massacre.

Contacts became accelerated in the last century. The Russian explorer Lütke paid a brief visit in 1828, and the French explorer Dumont d'Urville passed through in 1838. In the latter half of the century the rival governments of Spain and Germany began to show activity in the area and contacts with the outside world began to be more frequent. After the Germans acquired formal control just before the turn of the century, Ulithians began to be subjected to their first real contacts with civilization. Many of the men went to work for the Germans, usually as miners on Angaur and elsewhere. When the Japanese took over in 1914 they exerted an even greater influence, especially by setting up a school system on nearby Yap. While the culture of Ulithi has remained surprisingly intact in the face of these influences, there can be no doubt that diseases from the outside world now for the first time became real problems.

POPULATION STATISTICS

Published vital records for Ulithi, insofar as the writer knows, are virtually nonexistent, so that any discussion of population will have to be based on a rough approximation. The one exception to this unfortunate situation is a precise census taken by the writer as of January 1, 1949.

An explanation of the method of conducting the census is useful. The actual gathering of the data was begun on July 19, 1948, and continued intermittently until January 20, 1949. A mimeographed form was used which allowed for the recording of the following: name; sex; age; marital status; adoption; residence; birthplace; lineage or clan; name, birthplace, lineage or clan, and state of existence of father, mother, and spouses; the number of children by each marriage; the cause of termination of each marriage (divorce, death); religious belief (pagan, Catholic); extent of travel beyond Ulithi; nature of foreign contacts; linguistic aptitudes; outstanding pathologies; miscellaneous. The start of the census was made on Mogmog, where reliable informants named all

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persons known to them by memory and supplied preliminary data, such as sex, approximate age, and residence. This information was checked with separate lists sent in from outlying islands by designated agents. For several months the data on each personal census sheet were expanded through material derived from genealogies, information provided by selected informants fetched from other islands, direct interviewing of each individual inhabitant wherever feasible, and the recording of current changes in the vital statistics (births, deaths, marriages, divorces). A final check was made, just before and after January 1st, by gathering together on each island all the available inhabitants. In their presence and with their aid the census forms were put in order of birth from youngest to oldest. Ages were then recorded, in some cases being exact because dates of birth were known, and in other cases being approximate, in which event a system of interpolation with the known dates as guideposts was used. Here it was helpful, too, to make reference to historical incidents (typhoons, onset of the wars of foreigners) for estimating the ages of individuals not close in age to other individuals whose dates of birth had been well approximated. Visual inspection was used only as a crude adjunct. Excluded from the census were all transient residents; included were any Ulithians briefly absent on other islands.

This census (table 1 and figure 1) revealed that there were 200 males and 221 females on Ulithi, making a total of 421 permanent inhabitants. The population of each island, from largest to smallest, was: Mogmog, 142; Falalop, 126; Fassarai, 69; Asor, 53; and Lossau, 31. No other islands are at present inhabited, although we know that there were people living on Sorlen, Pigelelel, Mangejang, and Lam in the early part of the century.

It is evident from the population pyramid that there are few children and a high proportion of older people. In the absence of significant net migration this indicates low fertility and high longevity. The reasons for the rather large number of individuals in the 5–9 group are being investigated.

Comparative population figures for Ulithi are meager and not wholly reliable but they doubtless indicate that there has been a severe decline in population since early in the century (table 2). In 1904 Senfft ('04) made what seems to be a reasonably accurate estimate. From that year to 1949 the total declined to approximately 53% of what it had been at that time.

The 1904 figures can be broken down according to island (table 3),

TABLE 1

Population according to residence, age, and sex (1949)

Age	Mogmog			Asor			Falalop			Fassarai			Lossau			Total		
	♂	♀	T	♂	♀	T	♂	♀	T	♂	♀	T	♂	♀	T	♂	♀	T
0	0	1	1	2	1	3	2	1	3	0	1	1	0	1	1	4	5	9
1	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	2	0	2
2	2	0	2	0	1	1	0	1	1	1	1	2	0	0	0	3	3	6
3	0	0	0	1	2	3	1	0	1	0	0	0	0	0	0	2	2	4
4	0	0	0	0	2	2	0	0	0	2	1	3	0	0	0	2	3	5
0–4	3	1	4	3	6	9	4	2	6	3	3	6	0	1	1	13	13	26
5–9	14	13	27	1	3	4	4	1	5	1	2	3	0	4	4	20	23	43
10–14	2	5	7	0	0	0	2	1	3	3	1	4	3	2	5	10	9	19
15–19	8	4	12	2	5	7	1	3	4	2	2	4	0	0	0	13	14	27
20–24	6	7	13	3	1	4	4	3	7	2	1	3	0	0	0	15	12	27
25–29	5	4	9	3	0	3	3	5	8	4	3	7	0	0	0	15	12	27
30–34	2	1	3	2	1	3	3	6	9	1	1	2	1	2	3	9	11	20
35–39	3	9	12	2	3	5	2	0	2	2	2	4	1	0	1	10	14	24
40–44	3	5	8	1	1	2	6	10	16	5	0	5	0	1	1	15	17	32
45–49	6	3	9	0	0	0	7	8	16	1	0	1	2	1	3	16	12	28
50–54	6	5	11	0	1	1	3	2	5	3	6	9	1	2	3	13	16	29
55–59	3	3	6	1	3	4	5	7	11	0	4	4	0	0	0	9	17	26
60–64	5	3	8	2	5	7	5	2	7	1	1	2	1	2	3	14	13	27
65–69	2	0	2	1	1	2	4	1	5	3	4	7	2	1	3	12	7	19
70–74	2	6	8	0	1	1	4	6	10	3	1	4	0	1	1	9	15	24
75–79	0	1	1	0	0	0	3	6	9	1	2	3	0	0	0	4	9	13
80–84	1	1	2	0	1	1	0	2	2	0	0	0	0	1	1	1	5	6
85–89	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1
90–94	0	0	0	0	0	0	1	0	1	0	0	0	1	1	2	2	1	3
Total	71	71	142	21	32	53	61	65	126	35	34	69	12	19	31	200	221	421

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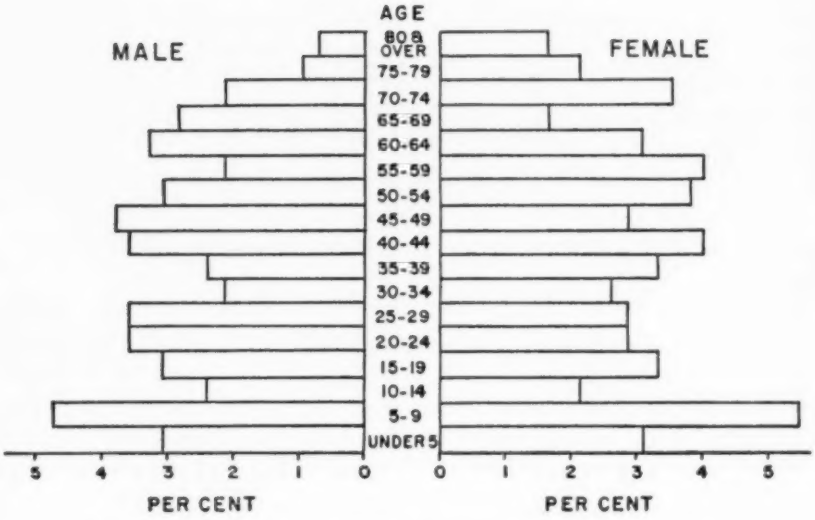

FIG. 1. AGE-SEX POPULATION PYRAMID FOR ULITHI (1949).

TABLE 2

Total population in various years

YEAR	POPULATION	SOURCE OF DATA
1870	ca. 700	Tetens & Kubary (1873)
1903	797	Senfft ('04)
1914?	ca. 700	Finsch ('14)
1925	506	Hasebe ('28)
1930	450	Hydrographic Office ('38)
1935	443	Hydrographic Officer ('45)
1946	402	U. S. Navy ('48)
1949	421	Lessa (present study)

indicating that one fourth the decline is due to the absence of people on the islands of Pigelelel, Sorlen, Mangejang, and Lam. Some of these people undoubtedly merely moved to other islands, e.g., Mogmog, where there has actually been an increase in population. But the figures for all the other islands now inhabited show strong losses, especially on Falalop, the largest of all the islands in the group, and Asor.

TABLE 3

Number of inhabitants on each island of Ulithi in 1904 and 1949

ISLAND	POPULATION	
	1904 (Senfft)	1949 (Lessa)
Falalop	260	126
Asor	101	53
Mogmog	95	142
Fassarai	79	69
Pigelelel	79	—
Sorlen	70	—
Lossau	59	31
Mangejang	42	—
Lam	12	—
Total	797	421

Part of the severe drop between 1904 and 1925 can be attributed to the great typhoon of March 30, 1907, which caused great damage. Of this disaster we have the following account from German records: The storm came in the morning from the west, overthrew the palms and other trees, and destroyed the houses. But there was no flood tide. About noon the storm veered towards the west, and in the afternoon it struck the island again, and finally that evening it subsided. The canoes came from all the other islands to Tharex, and begged him to pray to Yonelap to protect them. Tharex cast a spell, and then it began to rain. For a time the inhabitants had to eke out an existence with fallen nuts and pumpkins [squash], which are cultivated in great quantities. The Schooner "Germania" took the natives who wanted to leave to Yap and Saipan, so there was no famine (Damm, '38. *Cf.* also Kurtz, '07.).

The present inhabitants of Ulithi are inarticulate regarding this

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typhoon and its effects. Since repeated questioning has elicited little information of value, we are forced to rely on other sources. We know that whereas in 1904 there were 260 persons on the island of Falalop, there were only a little over a fourth that number in 1909, two years after the typhoon. This was the year when Ulithi was visited by members of the Thilenius expedition. The members of the expedition reported that according to Hellwig's and Lorenzen's estimations the population of Falalop consisted of about 100 persons; both had based their estimates on the number of dwelling houses. Hellwig, however, discovered a number of buildings that stood at present deserted or whose dwellers had died, so that 70 persons would be a more accurate estimate; but those inhabitants who might return from Yap, Angaur, and Saipan must also be taken into account (Thilenius and Hellwig, '27).

The question immediately arises as to what happened to the people as a result of the typhoon. Some departed from Ulithi for other islands, *e.g.*, Yap, Angaur, and Saipan. From the census data gathered by the present writer, we know that a good many people remained on these other islands for a long time and there gave birth to many individuals who now reside in Ulithi. Thus, a woman by the name of Lemaremokh was born on Saipan ca. 1917 and returned to Ulithi ca. 1928. Four others were born there, ca. 1912, 1915, 1918, and 1920, respectively, so their parents were on Saipan during those years. The writer has no data on whether the movement back to Ulithi was in dribbles or occurred at one time, but, according to informants, there are still many Ulithians living on Saipan. As for the other islands to which the Germans transported the refugees, we know that three Ulithians who are now adult were born on Yap ca. 1913, 1916, and 1918, respectively, their parents having presumably gone there after the typhoon. One Ulithian was born in 1913 on Angaur, of parents who probably had sought haven there.

Further verification of the effects of the typhoon can be seen in figure 2, which shows that the number of persons born before the storm was considerably greater than after it. That is, of those Ulithians now living more were born per year immediately before the typhoon than immediately after it. The average for 1903-1907 was 7.4 per year, whereas the average for the post-storm years of 1908-1914 was 4.0 per year. The downward character of the curve gains greater significance when it is kept in mind that attrition through age has been greater for those born in the earlier years than those born in the later ones. Ad-

mittedly, this method has its limitations, but I devised it as a substitute for actual birth records for the years involved. Some other reason may account for the drop since 1907, but I do not know what it may be.

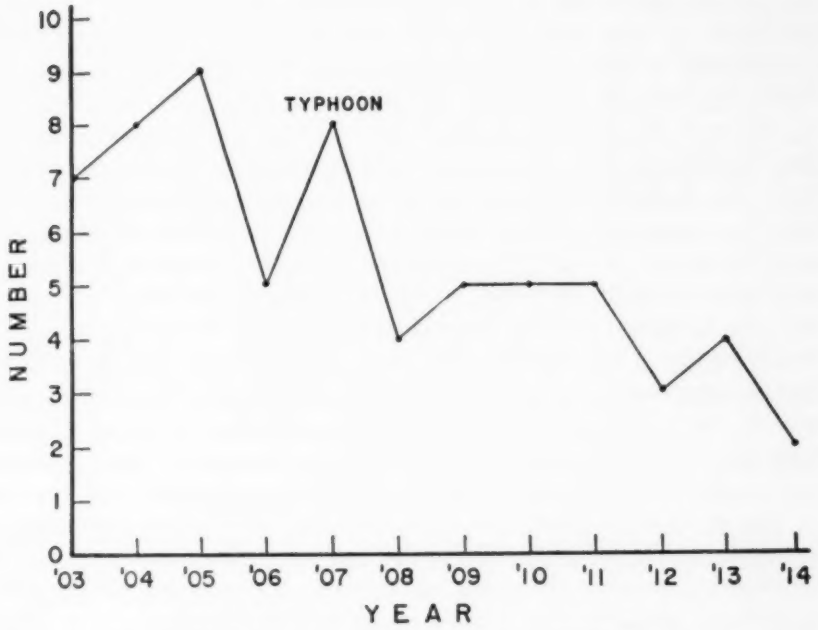

FIG. 2. NUMBER OF INDIVIDUALS LIVING ON ULITHI (1949) WHO WERE BORN BEFORE AND AFTER THE TYPHOON OF 1907, BY YEAR OF BIRTH.

A CONSIDERATION OF CERTAIN DEPOPULATION THEORIES

Having shown that there indubitably has been a decline in the population of Ulithi it is now in order to inquire into its causes. Since the typhoon of 1907 has held so important a place in the previous discussion we shall first evaluate it and other typhoons in general. Guided by the principle that a phenomenon which is not new can hardly explain a new trend, I have rejected the 1907 storm and all others as accounting for the present paucity of population. There are several reasons for this. Apparently no one was killed by the wind storm, and the German government provided early and sufficient aid. The immediate drop in population resulted from the removal of many natives to islands not struck by the typhoon, but most of these people eventually

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returned to their homes. If the storm had been truly castastrophic it should have left a greater impress on living residents, yet they know little about it. When Hellwig in 1909 asked the widow Suliven why Falalop had been so depleted of people she gave as her three reasons: an epidemic, the hiring of men to work abroad, and the loss of traveling canoes on the high seas (Thilenius and Hellwig, '27). It is notable that she did not list the typhoon as a factor. Certainly it seems to have nothing whatsoever to do with the small size of present day families, for births in the more recent years prior to 1949 have been abnormally low, without any indication of an upward movement in the population curve that would help recover the losses due to the typhoon. After all, this is a typhoon area and undoubtedly there have been many storms as severe as the one in 1907, which merely happens to have been fairly well recorded by the Germans. With the advent of colonial government with its modern facilities, the net effect of most storms seems to be that it results in the shifting about of peoples from one area to another, usually temporarily. It is interesting that many people now living, however, as permanent residents on Ulithi arrived there as refugees from typhoons on their own islands. In a case such as this, then, typhoons may create an increase in population through immigration.

Not much stock should be placed, either, in those theories of Micronesian depopulation which claim the loss of men at sea as a major contributing factor. Of course, the hazards of sea voyages in native proas are considerable in this far flung, typhoon battered area. The widow mentioned above was obviously impressed by the number of men who had lost their lives at sea in this manner. The songs still chanted on Ulithi often tell of the death of dear ones traveling to distant lands. The literature, from as far back as the 17th century, speaks constantly of the Europeans who have given aid to men blown from their courses. Earlier we saw how in 1721 some shipwrecked Ulithians came to the attention of Father Cantova on Guam. Parkinson writes of some natives of Ulithi who, in 1903, were being repatriated after drifting 900 nautical miles and landing on Halmahera. Senfft reports that in 1898 a typhoon struck a fleet of Ulithian canoes traveling to Fais and 120 people disappeared, and that later 7 canoes went out to search for these people but instead were blown to the Philippines. The Germans became so vexed at the expense they were incurring in the repatriation of survivors that they did their best to prevent travel in native canoes. As for the Japanese, they were not long in forbidding it by law.

Yet, while there is no doubt that many Ulithians have lost their lives at sea, this is not a serious cause of depopulation. The shipwreck theory has this weakness: it does not take into consideration that loss of life at sea is a constant over a long period. Indeed, there is every evidence that such loss of life was more common prior to depopulation than after. The shipwreck theory would hold good only if it could be demonstrated that travel on the high seas had increased, or that the art of navigation had declined, or that typhoons had increased in frequency. We know that the Micronesians were able seafarers, approaching the great Polynesian tradition. Another argument against the theory is that, whereas men may lose their lives at sea, the women they have left behind will continue to bear children, for it is an established fact that adultery and premarital license are common practices in the Carolines, as they must have been throughout all Micronesia. The shipwreck theory does not account for the fact that Fais, whose natives are known as poor navigators who seldom take to the high seas, have declined even more rapidly than Ulithians in number, despite a sex ratio of 127, according to data gathered in 1905 by Senfft ('06).

Nor does the author believe, as far as Ulithi is concerned, that depopulation has resulted from abortions, infanticide, or the use of contraceptives. The fact of the matter is that there is no attempt to curtail births. I could find no evidence of birth limiting practices. Ulithians want dearly to have children. Besides, any theory of depopulation which attributes decline to such factors would have to show that they had increased from times past when there had been a more abundant population.

Infrequency of coitus, which has been advanced as a cause of decline in Yap (Hunt *et al.*, '54), is another theory which cannot be given credence for Ulithi. While the author has not collected specific data on the topic, it seems obvious from having lived among the people for 9 months that intercourse is a pleasurable activity indulged in with great frequency. Adultery is common and premarital relations are readily permitted. It is true that for long periods women are confined to menstrual huts, so that men are not accessible to them. It is also true that abstinence is required by certain taboos. But these factors are not new ones; they have existed from the remote past. If anything, there are fewer occasions on which, for religious and other reasons, continence is required. The decline of paganism has meant a relaxing of the rules.

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Inbreeding is not a cause of depopulation on Ulithi, since actually the atoll is not as endogamous as one might suppose. For one thing, the incest range is so wide that it forces people to select mates not allied by anything but the remotest ties. For another, census figures show that despite the great distances which separate the islands of the Carolines, there has been much migration. While some of this movement is recent and has been fostered by administrative authorities, most of it is aboriginally inspired. For Ulithi, this is verified by an examination of genealogies, which shows ancestors coming from 9 islands outside

TABLE 4

Provenance of the parents of Ulithian residents (1949)

PLACE OF BIRTH	PERCENTAGE
Ulithi	80.0
Fais	4.4
Sorol	4.4
Woleai	1.8
Saipan	1.3
Ifalik	0.7
Yap	0.7
Lamotrek	0.6
Angaur	0.4
Ngulu	0.2
Faraulep	0.1
Eauripik	0.1
Unknown	5.3

the atoll. In 1909, according to Krämer, there were about 20 Fais women living on Ulithi. Table 4, which limits itself to the parents of the permanent residents of the atoll, provides exact evidence of the mixed character of the population. It is based on census figures for 1949. The high percentage of persons from Sorol is due to an influx following a typhoon. The large number of persons born on Fais reflects the closeness of that island to Ulithi. The relatively low percentage of people from nearby Yap is undoubtedly a result of caste restrictions. Some of the most important lineages and clans of Ulithi are, according to tradition, from distant islands in the Carolines. In view of the fact, then, that at least 15% of the people of Ulithi have "foreign" blood, so to speak, we can consider that a salutary exogamy obtains.

Ulithians remarry often, mostly because of divorce. There is no polygamy, for the marriages are always successive. Table 5 shows the number of times, by age groups, that individuals have been married. Younger persons, of course, have had less time to remarry, whereas older ones have had more opportunity. Therefore, while the average number

TABLE 5

Number of marriages per individual by age groups (1949)

AGE GROUP	NUMBER OF MARRIAGES											
	Males						Females					
	1	2	3	4	5	6	1	2	3	4	5	6
10–14	0	0	0	0	0	0	2	0	0	0	0	0
15–19	1	0	0	0	0	0	12	1	0	0	0	0
20–24	7	2	0	0	0	0	7	4	0	0	0	0
25–29	8	6	0	0	0	0	4	7	0	0	0	0
30–34	5	2	0	0	0	0	5	2	3	1	0	0
35–39	6	4	0	0	0	0	4	6	4	0	0	0
40–44	7	5	2	0	0	0	6	8	1	1	1	0
45–49	3	6	5	2	0	0	5	5	2	1	0	0
50–54	5	6	0	2	0	0	1	10	5	0	0	0
55–59	1	7	0	1	0	0	6	4	2	3	1	0
60–64	0	6	6	1	0	1	3	4	4	0	2	0
65–69	0	4	4	1	2	0	3	1	3	0	0	0
70–74	0	2	3	1	3	0	3	6	1	3	1	0
75–79	1	0	2	1	0	0	1	2	4	2	0	0
80–84	1	0	0	0	0	0	3	1	2	0	0	0
85–89	0	0	0	0	0	0	0	0	0	0	0	0
90–94	1	1	0	0	0	0	1	0	0	0	0	0
Total	46	51	22	9	5	1	66	61	31	11	5	0

of marriages contracted by all persons who have married is 2.05, that for persons 50 years of age or over is 2.46. Men marry more often than do women, the average for persons 50 years of age and over being 2.62 spouses for males and 2.34 spouses for females. These figures are conclusive evidence that marriage is a "brittle" affair on Ulithi, and if the memories of the older natives were more accurate on this score, it would be found that the average number of marriages contracted during their lifetimes would be even higher. The truth of the matter is that some Ulithians fail to recall, unless prompted, certain of the

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spouses to whom they were wed for but a short time. The effect of frequent marriage on population growth is difficult to assess, but since it is a constant we can ignore it.

The marital state of individuals on the atoll, as revealed in table 6, cannot be adduced as a cause for the decline. Ulithians marry early,

TABLE 6

Marital state of individuals by age groups (1949)

AGE GROUP	SINGLE		MARRIED		DIVORCED		WIDOWED		TOTAL		
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂+♀
10–14	10	7	0	2	0	0	0	0	10	9	19
15–19	12	1	0	10	1	3	0	0	13	14	27
20–24	6	0	9	10	0	2	0	0	15	12	27
25–29	1	1	13	7	0	2	1	2	15	12	27
30–34	2	0	5	9	2	2	0	0	9	11	20
35–39	0	0	10	14	0	0	0	0	10	14	24
40–44	1	0	11	15	3	0	0	2	15	17	32
45–49	0	0	12	9	3	1	1	2	16	12	28
50–54	0	0	10	10	3	2	0	4	13	16	29
55–59	0	0	7	9	1	1	1	7	9	17	26
60–64	0	0	13	3	0	4	1	6	14	13	27
65–69	1	0	8	3	1	1	2	3	12	7	19
70–74	0	1	6	5	1	3	2	6	9	15	24
75–79	0	0	4	4	0	2	0	3	4	9	13
80–84	0	0	0	1	0	1	1	3	1	5	6
85–89	0	0	0	0	0	1	0	0	0	1	1
90–94	0	0	2	0	0	0	0	1	2	1	3
Total	33	10	110	111[1]	15	25	9	39	167	185	352

[1] The discrepancy between the total number of married men and women is due to the fact that one of the husbands has gone to live on Yap, without, however, having divorced his wife, who remains on Ulithi and is considered married.

although not exceptionally so. Girls marry at least 5 years sooner than boys, starting, for the most part, when they have reached the 15–19 age group. There are few individuals not living in a marital state. Beyond the age of 24 there are only 5 single males and two single females. Divorce is very common, but the number of persons living in a state of divorce is small, being 15 for men and 25 for women. The number of widowed individuals is not high, considering the proportion of old people, but it is interesting that the number of widows is more than 4

times that of widowers. However, we must take into consideration that women of the age of 60 or over outnumber men 51 to 42—not a great difference, to be sure. Failure to marry, then, and failure to live in a married state, may not be considered causes of decline in population or the inability of the natives to effect a resurgence. There are only two women over the age of 17 who have never married. One is 25 years old and paralyzed in one leg; the other is 73 and psychotic. Of the men above the age of 17, thirteen have not married, but the majority of them are still in their twenties. It is interesting that informants insist people used to marry many years later than they do now. Should this be true, there is all the more reason to eliminate marital state as a factor in the depopulation.

Male absenteeism may have something to do with the low birth rate on Ulithi, but if so the effect has been very small. Able-bodied men used to go to work in German and Japanese phosphate mines on Angaur and Fais, so that for long periods of time they were away from their women. This is of course a new factor not previously operative under native conditions. It must to a large extent be minimized because of the prevailing attitudes towards extra-marital sex relations and illegitimacy. Along these lines it is interesting that the Harvard team studying depopulation on nearby Yap (Hunt *et al.*, '54) found that men with longer absences had a slightly larger number of recognized offspring than those with shorter absences. Even though the difference was not statistically significant it verifies my feeling that abstenteeism is a doubtful cause of lack of prolificacy on Ulithi. Another kind of absenteeism, resulting from the forcible impressment of most of the able-bodied adult male population into the labor service of the Japanese army on Yap around 1943-44, undoubtedly had a real influence in keeping down the birth rate because of the large numbers of men involved; but the effect was temporary and does not account for the previous decline.

As for the "loss of interest in life" theory popularized by Rivers ('22), it has no applicability to Ulithi, where the social system is still operating largely in autochthonous terms and the people display a great zest for life. Anyone who has visited the atoll can attest that there is no demoralization whatsoever. There is some drinking of fermented palm toddy, but my figures show that there are only one or two really heavy imbibers. Smoking is widespread among adults. No one has shown this to be a sign of demoralization. The practice, moreover, is an old one, for Carolinians have raised tobacco of their own for many

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years. Except for carpenter's tools and the like, there is no great envy of Western ways. Clothing remains almost completely native, and, it should be observed, is of healthful design. Houses are almost always of the old style and are kept clean and almost devoid of flies. While Christianity has made deep inroads since 1937, the effects, if anything, have been salubrious on morale. Ulithians who have been converted maintain it has created euphoria, and those who are still pagans show signs of wishing to embrace it. If in recent years, then, the size of families has decreased, it is not the result of an unconscious "race suicide" in protest against Europeans. So anxious are Ulithians to have children that they adopt them with eagerness, 45% of the people having been adopted either before birth or soon after. A fatherless child always has many potential adopters.

DISEASE AND DEPOPULATION

The one factor which has not been a constant among Ulithians is introduced diseases. It is my considered opinion that after Ulithi had been opened up to the outside world when the Germans assumed control in 1899, illnesses were introduced which subsequently had a highly detrimental effect on population numbers. Unfortunately, specific medical figures for Ulithi are virtually absent, for it has been the practice of the German, Japanese, and American governments to include Ulithi in general studies of the whole Yap area. Therefore, a good deal of what I shall have to say must be derived from indirect sources.

I wish to submit that gonorrhea alone has created enough havoc to merit a major role in the dispeoplement of the Carolines. The nefariousness of this disease is not that it kills but that it prevents women from conceiving. The impeding of impregnation is in the long run more injurious than death from the respiratory and other diseases apparently introduced in modern times. There is no way of knowing exactly when gonorrhea was introduced into the Carolines, but it does not seem unreasonable to assume that it became widespread after these islands had been opened up to the outside world by the Spaniards, and, later, the Germans and Japanese.

Unfortunately, no statistics are available to indicate the exact prevalence of gonorrhea on Ulithi, but in 1948 a medical officer of the U. S. Navy, during his tour of the atoll, stated to the author that his experience throughout the West Carolines showed that almost 80% of the adult population was afflicted with this disease. In his estimation, the per-

centage he named was possibly applicable to Ulithi, though he admitted that he had no figures and that his guess might be too high. This physician was of the firm conviction that the low birth rate on Ulithi and other islands of the area could be attributed to gonorrhea.

Pharmacist's mates attached to the LORAN station on one of the islands occasionally administer simple medical aid to natives and take vaginal smears. They, too, maintain that the rate of this venereal disease is unusually high. The natives themselves admit the strong prevalence of the disease, which they call *hasich*. It is regrettable that a thorough medical examination has never been made so as to provide us with precise figures, but there is no doubt in the mind of the writer that the proportion of persons infected by the gonococcus bacterium is inordinately high.

It is significant, in support of the gonorrhea theory, that when women and their husbands are suffering from the disease and they are treated with modern drugs, the birth rate increases. Reinfections, of course, readily occur, due to the prevalence of adultery and the lax regulation of premarital relations. But it is a matter of common knowledge among the natives that soon after a woman has submitted to western medicants for treatment she often bears a child, despite the fact that she may not have conceived for many years, if at all. In 1948, several men who had been sent to Palau for medical training returned to Ulithi and began a therapeutic program. Immediately, the number of pregnancies showed a spectacular increase, especially on the island of Falalop where treatment had been most intense. After I had left Ulithi in 1949 my former native assistant sent me some records of the births for that year and the following, and they pointed to a marked increase over previous years.

The gonorrhea theory of depopulation has had contrasting support. Figures published by the various governments in control of the Caroline Islands usually show it to be of moderate or even low incidence, but there is every reason to believe that examinations have been superficial and latent cases unobserved. At least one authority, however, whose publication I have not had an opportunity to examine, maintains that after an intense examination of 1,102 women on Yap, he found that 42.8% had gonorrheal vaginitis and endometritis, and that probably inflammations of the tubes and ovaries were also present. This same authority, a Japanese physician named Fujii, believes that the low birth rate on Yap has been due to this disease (Fujii, '34, cited by Hunt *et al.*,

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'54). Yap is a close neighbor of Ulithi and what applies there may also apply to its smaller dependency.

Respiratory diseases have taken a heavy toll in this century among the people of the islands. They have a great dread of influenza and bronchitis, which they feel are created by sorcerers sent over from Yap to punish them when they have broken taboos or failed to send tribute to their overlords (Lessa, '50). The effects of these diseases have aparently not been published specifically for Ulithi, but the records of the German and Japanese governments refer repeatedly to the high mortality resulting from them in the Yap administrative district, as well as in other parts of what is now known as the Trust Territory. Respiratory diseases seem no longer to be as fatal as they once were, but there is no doubt that they have had serious effects in the past. While emphasizing these infections, I believe that they are definitely subordinate to gonorrhea, for the major cause of depopulation on Ulithi is due simply to the failure of the women to become pregnant.

The large number of persons with paralyzed limbs bears testimony to the fact that there have been some severe epidemics of what seems to have been poliomyelitis, which struck soon after the Japanese administration began. Seven males and 5 females show paralysis, their ages ranging from 9 to 73, with a fairly even distribution in between. This means that 2.8% of the population shows signs of the disease, and when one considers that there may have been cases which did not survive the infection, and others which may have been of a non-paralytic type, it is obvious that we have here a force to contend with in the depopulation of the atoll.

Other diseases may be largely discounted. Dengue, filariasis, malaria, rickettsioses, typhus, typhoid fever, leprosy, and many other diseases are either absent or unimportant in this area. Syphilis is virtually nonexistent because, supposedly, of the prevalence of yaws, although the latter has been almost eradicated since the arrival of the American forces in 1944 (Wees and Thornton, '50). Tuberculosis, a serious problem in some parts of Micronesia, is not lethal on Ulithi. On one of the rare occasions in which the atoll is specifically mentioned in a medical report, it was discovered that in 1949 two persons examined by X-ray had "suspicious" cases of pulmonary tuberculosis, and one had tuberculosis of the lymph nodes. The people of Ulithi, according to this survey, which was made by the hospital ship, U. S. S. "Whidbey," in common with the other islands of the Yap district, seem to have considerable

resistance toward tuberculosis. Tuberculin skin tests showed a high percentage of the people gave a positive reaction. Apparently tuberculosis has been overrated as a factor in mortality rates for this area (McNair *et al.*, '49).

Intestinal parasites, especially trichuria and hookworm, are common, although less so than on most islands of the Yap district (McNair *et al.*, '49). Hunt and his associates ('54) are of the opinion that although intestinal parasites may have slightly depressed the birth rate on Yap,

TABLE 7

Age incidence of dental caries and tooth loss

AGE GROUP	NUMBER OF INDIVIDUALS				
	In Age Group	With Caries		With Lost Teeth	With No Caries or Lost Teeth
		Apical	Gingivial		
16–19	7	5	1	0	1
20–23	7	2	0	1	4
24–27	6	1	0	0	5
28–31	5	1	0	1	3
32–35	2	1	0	2	0
36–39	6	1	0	3	2
40–43	4	2	0	1	2
44–47	4	0	0	3	1
48–51	5	1	0	4	0
52–55	3	2	0	2	0
56–59	4	0	1	3	1
60–63	3	0	1	3	0
64–67	2	1	0	2	0
68–71	1	0	0	1	0
Total	59	17	3	26	19

it has not prevented some of the most seriously infected peoples of the world from having among the highest rates of population increase. In any case, to my knowledge these parasites are not a new factor on Ulithi and therefore must be discounted from that point of view, too.

Finally, malnutrition must be eliminated as an operative factor in the depopulation of Ulithi. Macroscopic inspection shows the people to have the appearance of good health and physique, especially in the case of males, who are unusually muscular and strong, with few traces of fat even in old age. In a group of 59 adult males studied anthropometrically, only one man in the sample showed outright fatness (Lessa and Lay, '53). Table 7 indicates that if teeth are a measure of good

health and nutrition, Ulithians surely rate high. Of the group of 59 men studied, almost one third had all their teeth and no caries. The highest incidence of caries is in the youngest age bracket, possibly reflecting deleterious contacts with military and other American installations during and after the war. According to the opinion of a civilian Navy dentist working on the atoll in 1948, tooth loss on coral atolls appears to be due more to pyorrhea resulting from heavy tartar deposits than to caries. This view seems plausible enough, for there is considerable calcium in the food and it creates deposits which are greatly irritating to the gums.

THE FUTURE

It now seems likely that the population of Ulithi will show a sharp upturn. Young girls have recently been trained in simple medicine and obstetrics, and the number of young men with medical training has reached a fair size. The U. S. government gives regular medical and dental treatment. Men no longer are removed from home in order to work abroad. Travel on the seas is almost entirely in modern vessels. The deleterious effects of typhoons have been removed by the ready assistance of American authorities, so that no one need starve. The author's prediction is that, if a strong health program is maintained and if special circumstances do not intervene, there may eventually be so many people on the atoll that some sort of control will be necessary. The possibility of overcrowding will not, however, be realized in the near future. Ulithi can support twice its present population, but it will take many years to reach that condition. The bare realities of the matter are this: The percentage of Ulithians below the age of 15 is next to the lowest of any of the peoples of Guam, Samoa, and the Trust Territory of the Pacific Islands for which data are at hand. This may readily be seen by consulting table 8, which shows the percentage of individuals of the age of 14 or less in the above-mentioned places, together with, for comparison, the United States, England and Wales, and Japan. So low a proportion of children if sustained is unhealthy from the point of view of survival.

Moreover, the number of persons 50 years of age or older is exceptionally high, 32.4% of the total. This may be compared with the following percentages for fast-growing populations: Saipan Chamorros, 8.9; American Samoa, 9.2; Guam, 10.3; Japan, 15.5. Of course, a high proportion of post-reproductive individuals does not in itself indicate an unhealthy situation. In 1949 in the United States, for

example, 19.6% of the people were in the post-reproductive category. It is when the old age ratio is high and the birth rate is low that the situation, as in Ulithi, becomes ominous.

There is enough room to expand, not only back to the high level of 1904 but even more. The density of population per square mile was 442.8 in that year and was only 233.9 in 1949. These figures are low when compared with some of the more densely populated atolls of

TABLE 8

Percentage of individuals of pre-reproductive age (under 15) in various places[1]

PLACE	PERCENTAGE
Outer Islands, Palau District (1948)	9.9
Ulithi (1949)	20.9
England and Wales (1948)	21.4
Yap (1947)	23.7
United States (1949)	27.1
Marshall Islands (1948)	30.0
Truk (1947)	32.2
Ponape (1948)	33.0
Japan (1948)	34.7
Palau (1948)	36.0
Saipan Carolinians (1946)	36.6
Guam (1940)	44.1
Saipan Chamorros (1946)	45.1

[1] Sources: Lessa (present study); United Nations ('50); U. S. Navy ('48).

the Carolinian area: Eauripik, 1633.3; Fauraulep, 750.0; Lukunor, 768.8; Losap, 1866.7; Namoluk, 734.4; Satawan, 782.4; Murilo, 716.0; Pingelap, 916.2, and Kapingamarangi, 930.8 (U. S. Navy, '51). There are several islands in the Ulithi group that were once occupied but later abandoned, and there are others that apparently have never been inhabited but could hold many families. Some of the abandoned islands were vacated upon orders of the Japanese, who wished to reserve them for raising copra, but Ulithians never have felt the need to reoccupy them even when at liberty to do so.

SUMMARY

In 1904 it was reported by the German government that the population of Ulithi stood at 797. A detailed census taken in 1949 by the

author showed a marked drop to 421, with a large proportion of old people and a small proportion of young ones.

Various possible causes for this decline are examined and rejected as being inapplicable, especially because most of them are not new factors and therefore cannot explain a new trend. Among them are: typhoons, shipwrecks, abortion, infanticide, contraceptives, infrequency of coitus, inbreeding, marital state, male absenteeism, and loss of interest in life. In connection with the last-named it should be observed that in 1949 Ulithian society was still operating largely in unacculturated terms and that native institutions were for the most part very vigorous.

Diseases introduced by Europeans seem to be the real reason for the decline. Of these, gonorrhea is the most important. This accords with the fact that the women of Ulithi do not become pregnant with sufficient frequency to enable the population to increase, or, at least, to maintain itself. Respiratory diseases too are very injurious to population growth. Osteomyelitis may be another major contributory cause. Other diseases, particularly tuberculosis, syphilis, trichuria, hookworm, and malnutrition, do not apply.

Beginning about 1948 the use of medicants to treat gonorrhea has apparently been responsible for a noticeable increase in pregnancies, and it is possible that the atoll will now witness a marked upturn in the population curve. If this should occur, there is ample room for almost a doubling of the population.

ACKNOWLEDGMENTS

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TECHNOLOGICAL ADVANCE AND MAJOR RACIAL STOCKS[1]

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WE HUMANS are a polytypic species. Both as individuals and as breeding populations, we differ from one another in numerous biological characteristics. The extent to which these differences are due to environmental influences during the growth of each individual has not yet been determined. It remains clear, however, that genetic differences do exist between the various tribes of men, and, naturally enough, attempts have been made to find some order in the variety. Most typically, scholars have attempted a three-fold division of our species: after all, three has long been a sacred number in our culture. So we continue to hear of Mongoloids, Negroids and Caucasoids as basic, primary or original stocks, from whom all of us today, by further evolution or hybridization are derived.

Some authorities, like Howells ('44), insist upon 4 rather than three; some, like Boyd ('50, pp. 268-272), speak of 6. Sergi ('11) divided us all into two original varieties, the Eurafrican and the Eurasiatic. Keith ('49, pp. 234-244) has written also of two basic groups, one being deeply pigmented or Negroid, the other being rather less pigmented but variable. Three is, however, the more orthodox number, and it must be noted that each is named after a group or type which is very numerous at our stage of history. Average or run-of-the-mill specimens of each stock, as described by the usual authorities, can also be recognized by anyone with our cultural perceptions as being different from either of the others.

Hooton's position with respect to the existence and primacy of the

[1] Presented at the annual meeting of Section H, American Association for the Advancement of Science, Berkeley, California, December 30, 1954.

three major stocks is made clear by his statement in *Up From the Ape* ('46, p. 449): "The differences between the various subgroupings within the three great or primary races are *obviously* more recent, and quantitatively and qualitatively *less* than exist between the primary races respectively." Kroeber ('48, p. 134) accepts this idea, albeit with some reservations. He refers, for instance, tc "remaining minor, aberrant forms which are best kept separate, provisionally. Some, like the Ainu and Australoid, appear to affiliate preponderantly with one of the three great classes." Ashley Montagu ('51, pp. 301, 304-306), on the other hand, apologizes for mentioning divisions or major stocks. Yet he goes on, at once, to speak of Nilotes as "probably hybrids between Hamites," whom he classifies as a branch of Whites and "Forest Negroes." He supposes a group whom he labels "Half Hamites" to have arisen in the same manner. Why, therefore, he distinguishes them from Nilotes he does not say.

It is, indeed, the existence of such groups as Nilotes and Ainu, the extraordinary distribution of dark-skinned pygmy types, the accumulation of findings concerning genetic characteristics, and the recent studies of climatic adaptations within the human stock, which lead me, at least, to doubt the existence, past or present, of two, three or 4 major stocks, or even of the 6 listed by Boyd ('50) from his study of blood-type distributions. Coon, Garn and Birdsell ('50, p. 115), indeed, state, that "a stock is not a race, but merely a convenience in classification: It is a lumping of races which seem similar to each other in broad categories." In fact, I wonder if the concept of the major stock does not usually serve to mislead the student of taxonomy, which is an inconvenience rather than a help. From the concept of the major stock flows, perhaps sometimes unconsciously, the assumption of genetic priority, which is explicitly accepted by Hooton.

Is this assumption well based? What is the evidence? Let us take a few cases.

The data of human genetics provides evidence of a remarkable difference in numerous characteristics within each of the major stocks. This is notably demonstrable in comparative serology. Some of the differences in gene-frequency do not correspond with the lines which are supposed to divide stocks. Boyd ('50, pp. 268-269), consequently, would separate the Basques from the Caucasoids, and the American Indians from the Mongoloids. The more we learn of human genetics, the greater the number of genetically distinctive groups we discover.

The data of palaeontology provide far better evidence concerning the regional antiquity, at least, of Bushmen (Galloway, '37), Australoids (Weidenreich, '45), Nilotes (Leaky, '35), Ainu (Hooton, '46, p. 402) than of Mongoloids and Negroids. Regional variety within the Caucasoid group appears to be as old as the group itself. The best fossil relics point to what Hooton calls sub-races or composite races rather than to the great primary races which are said to be the ancestral stocks.

The data from ethnology concerning the geographical distribution of living and recently living peoples provides most equivocal evidence. Although the Caucasoid stock appears to have its major center of distribution in Europe and the Middle East, it is alleged to have contributed genes to such groups as Ainu, Polynesians and Hottentots. Negroids are scattered, mostly in tropical areas, from Fiji and Tasmania to Senegal and Capetown, Negritos sporadically distributed among them. There are large gaps, by oceans, deserts, and intervening populations of quite different phenotype and genotype, which separate the dark-skinned tribes. Those who accept, even as a convenience, the prior existence of Negroids or Caucasoids as major stocks have had to exercise much ingenuity to explain these improbable distributions.

Kroeber ('48, p. 125), for instance, in writing of the Ainu, assumes that if they resemble Europeans (as he appears to think they do) they must be a *branch* of the Caucasian stock, they must have come from the West, and that they have no connection with the Mongolian Japanese among whom they now live. Further unstated assumptions which must logically underlie these statements are: that the Europeans are typical Caucasians, that the Japanese are typical Mongolians, that there is some other direction from which to reach Hokkaido and that the Ainu have always been, as they are now, a relatively small population. None of these unstated basic presuppositions can be demonstrated to be true, and, indeed, most of them are rather unlikely. The Ainu resemble native Australians at least as much as they resemble either European or Asiatic Caucasians. Japanese are not especially typical Mongolians. There is no particular reason to believe that the relative proportions now existing between the various racial and tribal groups, in numbers, have existed unaltered throughout prehistory.

Let us look again at the Nilotic tribes. If indeed they are nothing but hybrids between Negroids and Caucasoids one would expect them to be intermediate in genotype between the original stocks. As a matter of fact they possess a notably high incidence of the allele for sickle

cells, a low incidence in the allele for blood-group A, and a typically African incidence in the alleles for the Rh subtypes (Mourant, '54). One might expect them to be quite variable in phenotype, at least in skin color, if they are hybrids, but one finds them to be especially dark-skinned, and elongated in body-build far more than either of the presumptive ancestral stocks, Negroid or Caucasoid. In other words, they have numerous characteristics which can not be explained by the hypothesis of mixed ancestry.

Are they, on the other hand, more closely related to all other very dark skinned tribes, no matter where, than they are to less deeply pigmented peoples to the north, such as Caucasoids of the Mediterranean area? There is positively no indication or even suggestion from genetics that this might be so. We have no record of sicklemia in Melanesia, for instance, but the gene is known among Greeks, Sicilians and some tribes in India. Although blood-group A is very common among Melanesians, the subtype A_2 is unknown: both among Nilotic and Mediterranean peoples the ratio of A_2 to A_1 is high. The allele frequency of N is high in Melanesia, but much lower throughout Europe and Africa. The Melanesians are utterly un-African in Rh subtype distribution (Mourant, '54). Indeed, it seems to be reasonably clear that a considerable variety of very dark-skinned peoples exist, and that they are not necessarily closer cousins to one another than any of them are to less dark-skinned groups.

In fact, there are numerous peoples in the world whose characteristics simply can not be adequately explained by any of the theories derived from a belief in two, three or 4 original major stocks. Bushmen, Basques, Lapps, even Polynesians and American Indians just don't fit. Nevertheless, there they are, alive and breeding just like the rest of us. If one assumes that the major stocks are original, and the actual people of the world just a later derivation, great difficulties are created.

Now as a matter of fact people don't live, work and breed in racial groups, but in tribes, castes and other culture-bound groupings. Opportunities for spreading one's genes in distant places have, in the past, been limited. Most migrants move in groups, rather than individually. The social group, furthermore, modifies the natural or raw environment to a greater or lesser degree, depending upon its technology and social organization. Some forms of technology and social organization permit and encourage greater population densities than do others.

The invention of Neolithic ways of life was revolutionary in this

respect (Childe, '36). With agriculture, the population of a tribe could increase rapidly, and we have ample archaeological evidence to show that population movements followed this increase, as farmers sought new lands to cultivate. Areas previously rather useless to man could now be profitably exploited. Other technological advances have permitted the survival of individuals without climatic adaptation. Indeed, the better the technology, the higher the survival rate, no matter what the bodily form. Members of European royal families can even afford to have hemophilia.

Today the vast bulk of the world's population, although not all, can be squeezed somehow into one or another of the so-called major stocks. In seeking to uncover the story of ancestral relationships within the human stock, however, we should consider, instead, the most likely distribution of population before the Neolithic revolution. After all, that is less than 10,000 years ago, only 1% of the period of man's existence. The population explosions which resulted in the present distribution occurred only in limited areas at first, and, consequently, affected only a limited number of the population groups at the time. Yet these groups gained an initial advantage in numbers, and such an initial advantage is difficult to overcome. The genetic systems of populations which happen to have good tools are not better, in any sense of the word, than are the genetic systems of populations which lack good tools. The former do have a higher survival value than the latter, however, simply because the tools help their owners to survive and to multiply.

Now we can not, of course, reconstruct with any high degree of precision, the picture of the distribution of the world's population at the end of the Palaeolithic. Nevertheless, the advance of archaeological investigation and of ecological studies do permit us to come to logical conclusions with respect to relative sizes of populations inhabiting certain areas of the world in the days when all were food-collectors.

Before the beginning of the Neolithic, real forests, whether tropical jungle or temperate zone, were not especially desirable places for human habitation. From what we know of hunting and fishing peoples, we have every reason to believe that parklands, savannahs, prairies and the like can support denser populations, because of greater abundance of seeds and game and greater ease of collection and hunting. Consequently, we may be sure that Europe was not thickly inhabited, and the archaeological evidence suggests that, with new technologies, population movements from the Near East repeatedly came into Europe.

On the other hand, East and South Africa, then as now, appear to have been, like the Near East, land fit for hunting and collecting. It also appears to have been until even later, indeed much later, inhabited at least in part by Khoisans, or Boskopoids, presumptive ancestors of Bushmen. There is little or no reason to suppose that East and South Africa, home of the ancestors of Bushmen, were less densely populated than the Near East, home of the ancestors of modern Europeans. In area, the parklands, savannahs and prairies of the Near East, of what is now the Moslem world, from Pakistan to Morocco, do not exceed 2,500,000 sq. miles. Regions similarly favorable to hunting-collecting peoples, from an ecological standpoint, in East and South Africa cover an approximately equal area. Consequently, there is no reason to suppose that populations with genetic systems similar to those of Europeans were, 10,000 years ago, more numerous than were populations with genetic systems similar to those of Bushmen. Yet today the first is regarded as the typical representative of a major, primary stock, the latter as an aberrant and mysterious racelet.

Are we not fooling ourselves, in a case like this, simply because of the present day preponderance of numbers?—a preponderance due simply to the fortuitous correlation between Caucasoid types and the invention of agriculture and the technological developments which later, and doubtless consequently, ensued in history.

This, of course, is even more true if we consider the blondish varieties of Europeans. Many suspect that really extensive and widespread depigmentation is an adaptive character suitable to the climate of northwest Europe (Coon, Garn and Birdsell, '50, p. 50). It may very well be exceedingly ancient there. But this region, until only 5,000 years ago, was most sparsely inhabited by primitive savages. They are quite likely to have numbered only a few tens of thousands, if we can judge by population densities of peoples of equivalent economies and environments among today's hunting and fishing groups, such as the Yahgan.

Yet we unconsciously designate such Europeans as the standard Caucasoids, simply because there are now some hundreds of millions of people with such physical characteristics. Let us examine how this came about: here is one case concerning which we have ample historical documentation.

By the end of the Middle Ages, the population of the British Isles, the Low Countries and Scandinavia was still less than 10,000,000. Because of geographic position and historical circumstance, the British

emigrated in astonishing numbers, settling in lands previously only scantily occupied. Although in 1600 there were perhaps 3,000,000 there are now at least 150,000,000 of British stock. The world population has increased by 6 times in these last few centuries, that of British ancestry by 50 times. This is no sign of superior British virtue, mentality or fecundity, yet it is an evolutionary fact. Areas in Europe containing a high per cent of blondism held perhaps 3% of the world's inhabitants then. People originating from such areas comprise at least 12% of the world's inhabitants now. If the allele or alleles for blondness have increased proportionately (and, with modern technologies, blonds can survive even in the tropics, especially if they are in the upper class) blondness should now be more than 4 times as common as it was then. Technology, and historical events resulting from technology, have produced a remarkable change in the incidence of this allele. This is evolution in action.

The population explosion in part of the areas inhabited by Caucasians, remarkable though it has been, is not unique. Neolithic techniques, although apparently developed and originated very largely in areas occupied by people of this population group, have not been their unique possession by any means.

In China, for instance, food production took root long ago, with the result that the local population there began to expand also, with respect both to numbers and area occupied. The genetic characteristics of the Chinese, like those of the Europeans, have become much more common than they were in the Palaeolitic. The movement southward of peoples in East Asia is amply documented by ethnological distribution studies, linguistics, archaeology, history and indeed by contemporary events. Extensive hybridization, and migration as well, have followed culture-trait diffusion, so that both phenotypes and genetic systems typical of northeast Asia have spread more and more to the south, even into Indonesia.

As a result of this process, which has almost certainly taken place only since the application of Neolithic, or even Iron Age techniques, we find hundreds of millions of individuals with more or less Mongoloid characteristics spread along the western rim of the Pacific basin, and, scattered among them, in all sorts of refuge areas, populations which are clearly much less Mongoloid. At the end of the Paleolithic, the situation must have been far different, with few Mongoloids living in

the open lands to the north, and a great variety of populations with genetic systems quite unlike that of the Mongoloids in Japan, China, Indo-China and Indonesia. This proposition is so widely accepted that it need not be argued here, yet its implications with regard to the question of the genetic priority of major stocks seem to have been neglected.

It seems to me that we can be quite certain that 10,000 years ago the numerical proportions between populations of different genetic characteristics must have been violently different from what they are today. We do not yet have adequate data to postulate the typical characteristics of most of the tribal groups then in existence. But the numbers of tribes with genetic systems similar to the so-called Mongoloid and Caucasoid stocks must have been relatively few. Blonds were probably as rare then as Bushmen are today. The numbers of Bushmen, of Australoids, and perhaps of other populations as well, was relatively great, but probably exceedingly diverse genetically.

Changes in proportion, which have led us to attempt classification into three major stocks, have come about during the last 1% of human existence and have come about entirely because of a fortuitous correlation between more advanced technical skills and certain racial characteristics. Historical circumstances, not racial virtues, determined the expansion of a certain few among the many population groups which existed at the beginning of the Neolithic. When man succeeds in modifying his environment he directs the future course of his own evolution, albeit quite unaware of his direction, his speed, or even of the fact that he is in the driver's seat.

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THE NATCHEZ INNOMINATE BONE

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ON 6 October 1846, at a meeting of The Academy of Natural Sciences of Philadelphia,

Dr. Dickeson exhibited a large and remarkably varied series of fossil bones, obtained by him from the vicinity of Natchez, Miss. The collection embraces the entire head and half of the lower jaw of *Megalonyx Jeffersoni*, now for the first time discovered; together with many parts of the skeleton, and indeed of several skeletons of that animal, sufficient to enable its complete osteological reconstruction. The stratum that contains these organic remains is a tenacious blue clay that underlies the diluvial drift east of Natchez, and which diluvial deposit abounds in bones and teeth of the Mastodon giganteum.

The animals associated with the *Megalonyx* are, an *Ursus*, a *Bos*, two species of *Cervus*, one or two species of *Equus*, and several undetermined genera, all which are now in progress of delineation and description for the Academy's Journal. [The fossils actually discovered were *Mastodon americanus*, *Megalonyx jeffersoni*, *M. dissimilis*, *Ereptodon priscus*, *Mylodon harlani*, *Equus major*, and *Bison latifrons*].

Dr. Dickeson presented another relic of yet greater interest; viz., the fossil *os innominatum* of the human subject, taken from the above mentioned stratum of blue clay, and about two feet below the skeletons of the *Megalonyx* and other extinct genera of quadrupeds.

This ancient relic of our species, is that of a young man of about sixteen years of age, as determined by its size and form, and by the fact that the epiphyses have separated from the tuberosity of the ischium, and from the crista of the ilium.[1] Nearly all the os pubis is wanting, the upper posterior part of the ilium is broken away, and but half the acetabulum remains. That this bone is strictly in the fossil state, is manifest from its physical characters, in which it accords in every respect of color, density, &c., &c., with those of the *Megalonyx* and other associated bones. That it could not have drifted into the position in which it was found, is manifest from several facts: 1. That the plateau of blue clay is not appreciably acted on by those causes that produce ravines in the superincumbent diluvial; 2. That the human bone was found at least two feet

[1] This is incorrect. The bone is that of an adult.

below those associated skeletons of the *Megalonyx*, all which, judging from the opposition, or proximity of their several parts, had been quietly deposited in this locality, independently of any active current or other displacing power; and lastly, because there was an admixture of diluvial drift with the blue clay, which latter retains its homogeneous character equally in the higher part that furnished the extinct quadrupeds, and in the lower part that contained the remains of men. Dr. Dickeson has announced his intention of returning, at an early period of the present autumn, to resume his explorations in this prolific and most interesting locality; and it is earnestly hoped that his researches may lead to a further elucidation of this important question in science.

In this manner was announced the discovery of what has since come to be known as "the Natchez pelvis." At the meeting of the Academy held 2 November 1847 "Dr. Dickeson made some observations on the mode of compression of the cranium in use among the Choctaw Indians, and the supposed object of the same." Thereafter Dr. Dickeson vanishes from the stage and is heard from no more.

Fortunately, but a few months before he gave the account of the Natchez innominate at the Academy of Natural Sciences, Dr. Dickeson had shown both the site and the bones to Charles Lyell, the English geologist, then visiting the United States. From his letters (1881) it would seem that Lyell was in Mississippi sometime during the first three months of 1846. In the narrative of his visit to the United States Lyell (1849), recalling these recent events, writes:

In company with Dr. Dickeson and Colonel Wailes, I visited a narrow valley, hollowed out through the shelly loam recently named "the Mammoth ravine," from the fossils found there. Colonel Wiley, a proprietor of that part of the State of Mississippi, who knew the country well before the year 1812, assured me that this ravine, although now seven miles long, and in some parts sixty feet deep, with its numerous ramifications, has been entirely formed since the earthquake. He himself had ploughed some of the land exactly over one spot which the gully now traverses.

A considerable sensation was recently caused in the public mind, both in America and Europe, by the announcement of the discovery of a fossil human bone, so associated with the remains of extinct quadrupeds, in "the Mammoth ravine," as to prove that man must have co-existed with the megalonyx and its contemporaries. Dr. Dickeson showed me the bone in question, admitted by all anatomists to be part of a human pelvis, and being a fragment of the *os innominatum*. He felt persuaded that it had been taken out of the clay underlying the loam, in the ravine above alluded to, about six miles from Natchez. I examined the perpendicular cliffs, which bound a part of this water-course, where the loam, unsolidified as it is, retains its verticality, and found land-shells in great numbers at the depth of about thirty feet from the top. I was informed that the fossil remains of the mammoth (a name commonly applied in the United States to the

mastodon) had been obtained, together with the bones of some other extinct mammalia, from below these shells in the undermined cliff. I could not ascertain, however, that the human pelvis, had actually been dug out in the presence of a geologist, or any practised observer, and its position unequivocally ascertained. Like most of the other fossils, it was, I believe, picked up in the bed of the stream, which would simply imply that it had been washed out of the cliffs. But the evidence of the antiquity of the bone depends entirely on the part of the precipice from which it was derived. It was stained black, as if buried in a peaty or vegetable soil, and may have been dislodged from some old Indian grave near the top, in which case it may only have been five, ten, or twenty centuries old; whereas, if it was really found in situ at the base of the precipice, its age would more probably exceed 100,000 years, as I shall endeavour to show in a subsequent chapter. Such a position, in fact, if well authenticated, would prove that man had lived in North America before the last great revolution in the physical geography of the continent had been accomplished; in other words, that our race was more ancient than the modern valley, alluvial plain, and delta of the Mississippi,—nay, what is more, was antecedent to the bluffs of Port Hudson and Natchez, already described. Now that elevated freshwater formation, as I shall by and by endeavour to show, is the remnant of a river-plain and delta of extremely high antiquity; and it would follow, if the human race was equally ancient, that it co-existed with one group of terrestrial mammalia, and, having survived its extinction, had seen another group of quadrupeds succeed and replace it.

The good judgment and great authority of Lyell very properly served to put the Natchez innominate into the suspense account. But from the beginning there were objections to this. In a most able appendix on "Geology and palaeontology in connection with human origins," contributed to Nott and Gliddon's (1854) volume, Usher wrote:

One human pelvis found near Natchez, by Dr. Dickeson, is an undoubted fossil; yet we are told that ferruginous oxides act upon an *os innominatum* differently than upon bones of extinct genera lying in the same stratum, lest natural incidents might give to man, in the valley of the Mississippi, an antiquity altogether incompatible with received ideas: and Sir Charles Lyell accordingly suggests a speedy solution of the difficulty by saying that a fossilized *pelvis* may have fallen from an old Indian grave near the summit of the cliff.

In his book on the antiquity of man Lyell (1863) returned to a discussion of the Natchez innominate. Here Lyell points out that there had been an earthquake in the region around Natchez in 1811-12 and the earth, in consequence, had been much fissured.

One of the narrow valleys near Natchez, due to this fissuring, is now called the Mammoth Ravine. Though no less than seven miles long, and in some parts sixty feet deep, I was assured by a resident proprietor, Colonel Wiley, that it

had no existence before 1812. With its numerous ramifications, it is said to have been entirely formed since the earthquake at New Madrid. Before that event Colonel Wiley had ploughed some of the land exactly over a spot now traversed by this water-course.

I satisfied myself that the ravine had been considerably enlarged and lengthened a short time before my visit. and it was then freshly undermined and undergoing constant waste. From a clayey deposit immediately below the yellow loam, bones of the *Mastodon Ohioticus*, a species of megalonyx, bones of the genera *Equus*, *Bos*, and others, some of extinct and others presumed to be of living species, had been detached, and had fallen to the base of the cliffs. Mingled with the rest, the pelvic bone of a man, *os innominatum*, was obtained by Dr. Dickeson of Natchez, in whose collection I saw it. It appeared to be quite in the same state of preservation and was of the same black colour as the other fossils, and was believed to have come like them from a depth of about thirty feet from the surface. In my "Second Visit to America," in 1846, (Vol. ii, p. 197) I suggested as a possible explanation of this association of a human bone with remains of a mastodon and megalonyx, that the former may possibly have been derived from the vegetable soil at the top of the cliff, whereas the remains of extinct mammalia were dislodged from a lower position, and both may have fallen into the same heap or talus at the bottom of the ravine. The pelvic bone might, I conceived, have acquired its black colour by having lain for years or centuries in a dark superficial peaty soil, common in that region. I was informed that there were many human bones, in old Indian graves in the same district, stained of as black a dye. On suggesting this hypothesis to Colonel Wiley of Natchez, I found that the same idea had already occurred to his mind. No doubt, had the pelvic bone belonged to any recent mammifer other than man, such a theory would never have been resorted to; but so long as we have only one isolated case, and are without the testimony of a geologist who was present to behold the bone when still engaged in the matrix, and to extract it with his own hands, it is allowable to suspend our judgment as to the high antiquity of the fossil.

Vogt (1864) reproduced Lyell's 1849 account of the Natchez bone in his *Lectures on Man*.

Leidy (1869) states "The specimen may have been cotemporary (*sic*) with the remains of extinct animals, with which it is said to have been found, though it appears to me equally if not more probable that it may have fallen into the formation, from an Indian grave above, at a comparatively recent date, and became stained like the true fossils, from ferruginous infiltration."

Twenty years later Leidy (1889) repeated the same view.

Schmidt (1872), who had examined the Natchez innominate and measured it, presented a detailed analysis of the geological evidence, and concluded in favor of the high antiquity of the bone. He pointed

out that the bone is really that of an adult, but so damaged that it resembles the innominate of an immature individual. Disagreeing with Lyell he considered the bone to date from the Champlain epoch.

Fragen wir nach dem Alter des Natchez-Fossils, so egiebt sich, dass ein ganz beträchtliches sein muss; sein Zeit fällt in die Champlain-Epoch, welche, wie wir früher sahen, der grössten Ausdehnung der Gletschen in Amerika folgt. Das Mastodon, Megalonyx und ein ganz Reihe anderer postteriärer, jetzt ausgestorbenen Thiere noch mit dem Menschen und dem Besitz des Landes.

It has been long believed that the exact location of the Natchez site has been lost to human knowledge. Thus Sellards (1852) writes, "If the exact location from which Dickeson originally obtained the fossils can be re-located, valuable additional discoveries might be made." Actually the fairly exact description of the location of the site has been in print since 1873. In that year Foster (1873) gave an account of the Natchez find, and went on to introduce some "MS Notes, committed to the Author," writing as follows:

In this conenction I would introduce the testimony of a highly competent observer, Porfessor C. G. Forshey. He states:

"I examined the spot where the bone was found—in Berbard's Bayou, just above the bridge, on the Pine-ridge road, two and one-half miles from Natchez. The material from which it was taken was a dark loam in the bottom of the thirty-feet bayou. It was probably not *in situ*, but this loam, and the bone too, probably had caved in from some point above, and had been drifted thither from fields of several miles square, above the road. A dozen plantation burial places, and Indian mounds and camps had been exposed above for centuires; and in recent years, since inhabited by the whites (for a hundred years), the drains had cut through the surface to the depth of twenty and even forty feet in the bluff loam-beds. The probabilities are a hundred to one, that this bone was not of the Bluff (mastodon) formation, but of the recent era.

"The mastodon bones and all others, of which there were many, whelmed in the floods which deposited the bluffs, were all rotten. We had the utmost difficulty in preserving any of them—tusks or bones, and only succeeded when we had varnish or glue at hand to protect them. No human bones of any kind were ever found, unless this pelvic bone is an exception."

Forshey had apparently made extensive studies of the geology of the Mississippi basin. Lyell refers to him several times in the 1850 edition of his *Principles of Geology*. Lyell refers to "Mr. Forshey, an eminent engineer . . ."

In the 'nineties Thomas Wilson of the National Museum at Washington became acquainted with the method of dating bones by fluorine

analysis through reading Carnot's 1893 paper on that subject, and in that year submitted for analysis samples of bone taken from the Natchez innominate and from an associated *Mylodon harlani* to Professor R. L. Packard, who was then working in the laboratory of the Museum. The samples from the human bone proved inadequate for analysis, and it was then that the large hole was produced in the iliac blade by removing the button of bone from it. The second test proved satisfactory, and in 1895 Wilson published the results. The fluorine and anhydrous phosphoric acid determinations obtained by Packard were as follows:

	%F	$\%P_2O_5$
Natchez human pelvis	0.38	20.77
Natchez *Mylodon harlani*	0.28	26.59

Wilson submitted samples of the same bones to Mr. Hildebrand, "a chemist of the United States Geological Survey, on duty at the National Museum, who furnished the following results of his analysis."

TWO FOSSIL BONES

		Man Per cent	*Mylodon* Per cent
Loss at 100°C		4.55	6.77
Loss on ignition		16.54	21.18
Silica	(SiO_2)	22.59	3.71
Phosphoric acid	(P_2O_5)	17.39	23.24
Alumina	(Al_2O_3)	3.21	4.02
Iron protoxide	(FeO)	5.65	4.44
Manganese protoxide	(MnO)	1.65	3.40
Lime	(CaO)	25.88	30.48
Magnesia	(MgO)	0.95	0.78

From these findings Wilson (1895, p. 305) concludes "The importance of this analysis will be apparent at a glance. The human bone is in a higher state of fossilization than is that of the mylodon." Wilson's overall conclusion from the evidence of these analyses is "(1) that according to the averages made by Mons. Carnot, the bones under present consideration, the man and the Mylodon, are substantially of the same antiquity, and (2) by the same comparison their antiquity is about midway between the modern bones and those of the Quaternary geologic epoch" (p. 725).

At about the time that Wilson became acquainted with Carnot's paper Brinton delivered himself of some admirable cautionary remarks which all modern workers would do well to consider. Brinton (1893) wrote:

It seems to me . . . that this test, which I learn about from an abstract in the Journal de l'Alliance Scientifique, March 15, is open to some serious risks. Not only do the inorganic constituents of bone differ largely in the different osseous tissues of the same skeleton, but they notoriously vary at the different epochs of life. According to the analyses of Heintz, the fluoride of calcium in the average femur of an adult is about 3.5 of its inorganic constituents. Where the proportion in ancient bones differs notably from that in modern, how can we decide what part of it is owing to post mortem changes conditioned on the quality of the soil, the amount of percolation, the length of exposure before inhumation, and the like incidents? While it would be most desirable to have at hand a positive chemical test of antiquity, we must hesitate to accept as conclusive one which seems exposed to be influenced by these precarious conditions.

Hrdlička (1907) dismissed the Natchez bone as "a defective right os innomination, which, on comparison with a similar recent Indian bone, shows nothing peculiar. This is really all that can be said regarding it, and it would be quite useless to speculate as to its antiquity."

Most subsequent references to the Natchez innominate have all been to its equivocal status. The Wilson report had been completely overlooked, until it was rediscovered by Stewart in 1951. Before that time, however, and without any knowledge whatever of the work of Wilson, I decided to submit samples of both the Natchez human innominate and of the associated Mylodon to the fluorine test. With the kind cooperation of Dr. Horace Richards of the Academy of Natural Sciences of Philadelphia, in the Spring of 1948 I took with me to England samples of these two bones, and with the generous assistance of Dr. K. P. Oakley these samples were submitted to Mr. C. F. M. Fryd of the Department of the Government Chemist at London. The Natchez human sample proved insufficient for fluorine analysis, whereupon Dr. Richards most generously forwarded a larger sample of the human bone to London. This delay together with the accumulation of much pressing work in the London laboratory, prevented the analysis from being undertaken until recently. The results became available on 16 March 1954.

	%F		$\%P_2O_5$	
	Wilson	Present Study	Wilson	Present Study
Natchez innominate	0.38	0.88	20.77	26.2
Mylodon harlani	0.28	0.99	26.59	20.1

When we place these recent determinations by the side of those of Wilson, it will be seen that there is a pretty good agreement between the two. It being understood that variations between 20% and 26% P_2O_5, and between 0.2% and 0.4% F might well be found within a

single specimen. For example, two portions of an antler from the Swanscombe gravels gave these results: %F 2.6, 2.2, %P_2O_5 30, 34.5.

The results of the chemical tests which have so far been applied to the human and extinct *Mylodon* bones indicate that they are of the same or similar age. Bearing all the necessary cautions in mind it may, then, be concluded that it is probable that the Natchez innominate and that of the extinct ground sloth *Mylodon harlani* found in association with it are of the same or similar age.

SUMMARY

1. An historical survey of the literature relating to the human innominate bone found at Natchez in 1845 presents the evidence relating to the antiquity of the bone.

2. A new study of the fluorine and anhydrous phosphoric acid content of the human ($F = 0.88\%$, $P_2O_5 = 26.2\%$) and associated *Mylodon harlani* ($F = 0.99\%$, $P_2O_5 = 20.1\%$) is reported.

3. The results of the chemical tests reported by Wilson in 1895 and those of the present study are in pretty fair agreement, and indicate that the Natchez human and *Mylodon* bones are of the same or similar age.

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LIFE EXPECTANCY IN THE CITY OF CHICAGO 1880–1950

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ALTHOUGH extensive contemporary mortality data are available, no historical series of comparable life tables has been constructed for large cities. Such a series of life tables for the City of Chicago is presented here. These life tables are of interest not only because they describe the dramatic decline in mortality rates during the past 70 years, but also because life table values may be used to construct generation life tables which give a picture of the mortality experience of an actual population rather than the customary synthetic population described in most life tables.

We shall begin by tracing the great increase in expectation of life which has taken place in Chicago during the past 70 years. Life tables have been prepared for males and for females for each decennial period from 1880 to 1950. The method of life table construction used is a derivation of the Reed-Merrell method, with the major difference being in the treatment of the age group 1–4 years by single years of age rather than as a group. The reason for this is that the rates of child mortality were so great in the early decades covered by the Reed-Merrell analysis as compared to present-day rates, that a consolidation of several years for our study would result in considerable loss of accuracy in total life expectancy.

The raw data needed a number of modifications and adjustments before mortality rates could be computed. Major adjustments were required in the population data for children under five years of age. A number of standard demographic techniques were employed to effect the necessary corrections both in the under-enumeration of population

and the under-registration of births.[1] Further adjustments were required to effect comparability and also to supply missing pieces of information.

LIFE EXPECTANCY AT BIRTH

Total life expectancy at birth will be analyzed first. Table 1 presents the results for each decennial period.

TABLE 1

Expectation of Life at Birth and at One Year of Age, by Sex, City of Chicago: 1880-1950

	1880	1890	1900	1910	1920	1930	1940	1950
Males								
Age 0	38.0	37.0	46.2	45.8	54.3	56.6	61.5	64.8
Age 1	46.3	45.6	51.7	51.9	58.2	60.3	62.5	65.7
$\mathring{e}_1$ less $\mathring{e}_0$	8.3	8.6	5.5	6.1	3.9	3.7	1.0	0.9
Females								
Age 0	40.6	40.9	50.8	51.6	57.5	60.4	66.1	70.5
Age 1	46.8	47.9	55.4	56.8	60.4	62.6	66.8	71.0
$\mathring{e}_1$ less $\mathring{e}_0$	6.2	7.0	4.6	5.2	2.9	2.2	0.7	0.5

It should be noticed that the gain in average length of life was abut 27 years for males and about 30 years for females.

Very few series of life tables extend back as far as 1880. One such series exists for England and Wales. (Dublin, Lotka, and Spiegelman, '49, and United Nations Demographic Yearbook, '52). In 1880, life expectancy for males in England and Wales was 42.4 years, and in 1951 it was 65.8 years—a gain of 23.4 years; for females these figures were 45.8 years, 70.9 years, and 25.1 years, respectively. Thus, the net gain was not as much, but life expectancy was higher in England and Wales in 1880. Life expectancy in Chicago was very similar to that in England and Wales in 1950.

In addition to the net increase in life expectancy during the total 70-year period, it is also of interest to examine the extent of this increase by decades. Reference to table 1 will make clear that this increase was not linear in nature. It increased between 1890 and 1900, stayed at this level for a period (1910), and then increased to another level (1920).

[1] The birth registration could not be assumed to be complete until about 1925.

Length of life for males in 1890 was slightly less than in 1880. It was also true, but to a greater degree, in the states of New Jersey and Massachusetts, the only other areas of the United States for which life tables are available. The decreases in life expectancy in these early decades are characteristic of high mortality rates which are at the same time highly variable. As mortality rates decreased, they also became steadier.

In the period from 1890 to 1900, there was a 10-year increase in life expectancy, the greatest gain of any decennial period. Between 1900 and 1910 there was no increase, and a slight decline in length of life among males. By 1920 life expectancy was again increasing, and the 30-year period, 1920-1950, showed an increase in each decade.[2]

Differences in life expectancy at birth between males and females is most interesting. In 1880, females lived 2.6 years longer than males. This difference increased every year until 1910, when it stood at 5.8 years. In 1920 there was a sharp reduction in the gap, and it declined to 3.2 years. Again a steadily increasing difference prevailed until 1950 when it reached 5.7 years. The precise causes for this are not discernable here, but they are certainly worthy of further investigation.

LIFE EXPECTANCY AT SELECTED AGES

By subtracting the life expectancy at birth from the life expectancy at one year of age, the effects of mortality in the first year of life can be isolated (table 1). If infant mortality is excluded, the gain in life expectancy is not as spectacular although it is still of considerable magnitude. Life expectancy for males at one year of age has increased about 19 years since 1880, and for females about 24 years in the same period.

[2] After 1920, Negroes represented a constantly increasing proportion of the population of Chicago. Mortality rates of Negroes have been higher than those of white persons residing in the same area. Thus, the life tables of 1880-1910 pertain to an almost wholly white population and the life tables of succeeding years are based partly on nonwhite persons. While it would have been possible to construct life tables for white persons only for these periods, it was not done here since the object was to show the life expectancy of the total population as affected by the sum of all social influences. If it could be shown that Negroes had a lower life expectancy because of biological differences, separate life tables for white persons would be justified. However, a study of racial and economic differentials in life expectancy in Chicago indicated that most of the difference in length of life between whites and Negroes is accounted for by economic differences (Mayer, '50).

Of the total gains of 27 years for males and 30 years for females, gains of 7 and 6 years, respectively, may be traced to the reduction in infant mortality. Infant mortality has declined in much the same manner as has total mortality. That is, infant mortality has declined each decade between 1880 and 1950 with the exception of 1900-1910, at which time it increased slightly.

With regard to differences between males and females in expectation

TABLE 2

Net Change in Years of Life Expectancy at Various Ages for Decennial Periods, By Sex, City of Chicago: 1880-1950

AGE	1880-1890	1890-1900	1900-1910	1910-1920	1920-1930	1930-1940	1940-1950	1880-1950
Male								
0	—1.0	+9.2	—0.4	+8.5	+3.1	+4.1	+3.3	+26.8
1	—0.7	+6.1	+0.2	+6.3	+2.1	+2.2	+3.2	+19.4
5	—2.6	+3.9	0	+5.4	+1.0	+1.2	+3.0	+11.9
15	—4.1	+3.0	—0.4	+5.6	+0.5	+0.4	+2.8	+ 7.8
25	—3.4	+2.1	—0.8	+5.2	+0.4	—0.2	+2.4	+ 5.7
35	—3.5	+1.4	—1.0	+4.9	—0.1	—0.6	+1.9	+ 3.0
45	—2.8	+0.7	—0.8	+4.2	—1.6	+0.1	+1.3	+ 1.1
55	—2.3	+0.5	—0.6	+3.0	—1.3	—0.2	+0.5	— 0.4
65	—1.5	+0.1	—0.1	+1.8	—0.9	—0.1	+0.5	— 0.2
Female								
0	+0.3	+9.9	+0.8	+5.9	+2.9	+5.7	+4.4	+29.9
1	+1.1	+7.5	+1.4	+3.4	+2.2	+4.2	+4.2	+24.0
5	—0.8	+5.0	+1.2	+2.5	+1.1	+3.3	+4.0	+17.3
15	—1.8	+3.6	+1.0	+2.2	+0.9	+2.6	+3.7	+12.2
25	—1.4	+2.5	+0.7	+2.1	+0.4	+2.0	+3.4	+ 9.7
35	—1.2	+1.4	+0.4	+1.8	0	+1.6	+2.9	+ 6.9
45	—1.3	+1.0	+0.2	+1.7	—0.5	+1.3	+2.3	+ 4.7
55	—1.9	+1.5	+0.1	+1.1	—0.4	+1.0	+1.3	+ 2.7
65	—1.9	+1.5	+0.1	+0.7	—0.1	+0.5	+0.9	+ 1.7

of life at various ages we see in general that the gain in life expectancy for females has been greater than for males. In addition the increase in life expectancy for females has been steadier and less subject to fluctuations than that of males. Life expectancies of females have shown a net gain in each decade, except in 1880-1890 and 1920-1930, when small decreases were observed in the higher age groups. This is not as true for males, especially in the older age groups, and there has been an actual decline over the whole period for males above 55

years of age. This would seem to suggest that different or at least additional forces govern male mortality rates at a given time. Differences in occupation and social roles might account for this. However, the accuracy of the figures for ages above 55 years is questionable due to both errors of reporting and the method of life table construction employed here.

Summarizing these age differences as they appear in table 2 we can see that the bulk of the gain in life expectancy of both males and females is due to reduction in mortality rates among the young (0 to 15 years). Among males only 21% of the total gain in years of life can be attributed to reduction in mortality rates of men over 25 years of age.

Survivor Rates for the Period 1880-1950

While the expectation of life at various ages is a concise device for describing the mortality picture, another life table function—the number of survivors at various ages—portrays more graphically the social effects of mortality. Table 3 is based on the survivors of an initial cohort of 10,000 persons.

TABLE 3

Survivors at Selected Ages, by Sex, City of Chicago: 1880-1950

AGE	1880	1890	1900	1910	1920	1930	1940	1950
Male								
0	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
1	8,037	7,942	8,756	8,647	9,172	9,364	9,682	9,708
5	6,830	6,984	8,145	8,074	8,761	9,115	9,591	9,655
15	6,236	6,548	7,814	7,793	8,481	8,883	9,485	9,606
25	5,844	5,999	7,358	7,425	8,172	8,611	9,314	9,499
35	5,285	5,377	6,788	6,867	7,701	8,230	9,022	9,331
45	4,706	4,571	5,972	5,995	7,030	7,892	8,409	8,928
55	3,928	3,614	4,812	4,739	6,109	6,701	7,189	8,003
65	2,880	2,381	3,310	3,083	4,607	4,808	5,133	5,790
Female								
0	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
1	8,489	8,343	8,994	8,924	9,360	9,498	9,749	9,788
5	7,195	7,358	8,401	8,378	8,987	9,278	9,679	9,746
15	6,593	6,865	8,096	8,110	8,752	9,085	9,597	9,712
25	6,144	6,310	7,695	7,771	8,431	8,834	9,451	9,640
35	5,577	5,678	7,166	7,312	8,020	8,490	9,203	9,511
45	4,967	5,062	6,519	6,695	7,409	7,978	8,755	9,256
55	4,277	4,416	5,608	5,781	6,623	7,072	7,902	8,736
65	3,219	3,201	4,194	4,335	5,178	5,432	6,322	7,262

Of 10,000 infants born in 1880, almost 18% died during the first year of life. In the year 1950, of a cohort of 10,000 male births about the same number of persons survived to age 55 as survived to one year of age in 1880. In 1880, 58% of the males survived to 25, while about the same number survived to age 65 in 1950. Among females the changes have been even sharper. Almost the same number of females as attained one year of age in 1880 attained age 55 in 1950. In terms of the older age groups we see that more than twice the number of females attained age 65 in 1950 as did in 1880.

Table 3 demonstrates clearly that the past 70 years produced profound changes in the mortality picture in the city of Chicago. The social and psychological consequences of a far greater expectation of life on the family, the labor force, other social and cultural institutions, and social organizations in general have been far reaching.

The Generation Life Table

In addition to enabling us to analyze the mortality trends over a 70-year period, a decennial series of life tables makes possible the construction of a generation life table. Instead of using mortality rates as of a single point in time, the generation life table employs the observed mortality rates appropriate to a number of time points. For example, while the fixed mortality table for 1880 is based on observed death rates for all ages in the year 1880, the generation life table for 1880 is based on the 1880 mortality rates for persons under 10 years old,[3] the 1890 mortality rates for persons between 10 and 20, the 1900 mortality rates for persons between 20 and 30, and continues in this manner until the cohort reaches advanced age. Essentially, the fixed mortality life table is a description of a hypothetical population, since the mortality rates are as of a single point in time for all age groups. The generation life table may be applied to an actual population, and is therefore a more realistic picture of the mortality experience of a population group. Ideally then, the generation life table is a description of the mortality experience of an actual population living in a given locale. Actually, migration distorts the picture to some degree. Never-

[3] This method of constructing a generation life table differs somewhat from that suggested by Dublin, Lotka and Spiegelman ('49) in that it is like a fixed mortality life table within each 10 year age grouping. If mortality rates are changing very rapidly this results in some loss of accuracy, especially in the first 10 years of life. However, the net effect on life expectancy at birth is small.

theless, the generation life table comes closer to describing the mortality experience of a real population than does the fixed mortality life table.

The 1880 generation life table can be said to apply to that cohort of persons born in Chicago in 1880, and living their life in that community. Comparison of this table with the fixed mortality life table for 1880 leads to the conclusion that the males have encountered an exceptionally severe mortality condition in their lifetime. The life expectancy at birth for males is the same (38.0 years) for the 1880 generation as it was for the 1880 fixed mortality table (38.0 years). Among females the life expectancy of the 1880 generation (42.9 years) exceeded its life expectancy at birth (1880) by 2.3 years.

A number of factors partially or wholly accounting for this situation might be suggested. Instead of the closed system as proposed above, there has in fact occurred a larger amount of immigration to this city. These immigrants have been predominantly male.[4] If the above tables could be constructed on the basis of nativity, different results might be found. Other possible factors might be: first, that this cohort was born too early to take advantage of any later advances in infant and childhood mortality reduction; second, that this cohort attained working age just at that time (1895-1900) when the hazards of industry and occupation were at their worst; and third, that this group reached the middle ages (55 years and over) just at the time that mortality rates for males increased slightly.

Rather than speculate on a situation for which evidence is lacking, it will be more fruitful to see if this situation applies to the cohort born in 1890. Accordingly generation life tables by sex were constructed for that cohort.

It is evident from these data (table 4) that the 1880 cohort did not fare nearly as well as the 1890 cohort in exceeding its life expectancy, as computed by the fixed mortality schedule as of the time time of their birth.[5] Further, in both cohorts, the females have exceeded their initial life expectancy to a greater degree than have the males. The cohort of 1900 fared somewhat differently during its collective life time. The life expectancy of males increased by 4.7 years and that of females by

[4] In 1920 the sex ratio among the foreign born in Chicago was 116.

[5] Generation life tablest have been calculated for the 1890 Masachusetts cohorts, (Dublin, Lotka and Spiegelman, '49) and results were consistent with ours. In Massachusetts the 1890 male cohort outlived its life expectancy at birth by 4.2 years and females 5.8 years.

3.2 years. The greatest gains were made by males in the 5–34 year age group.

TABLE 4

Expectation of Life at Selected Ages for Generation Life Tables and Difference Between Generation and Fixed Mortality Life Tables for the Cohorts of 1880, 1890, and 1900, by Sex, City of Chicago

	1880		1890		1900 [1]	
AGE	Gen. L.T.	Diff.	Gen. L. T.	Diff.	Gen. L. T.	Diff.
Male						
0	38.0	0	40.8	+3.8	50.9	+4.7
5	50.1	—0.1	52.9	+5.3	57.3	+5.8
15	44.2	—0.4	45.9	+5.4	49.4	+5.9
25	37.2	0	38.2	+4.4	41.2	+5.3
35	29.9	—0.7	30.9	+3.8	33.0	+4.5
45	23.5	—0.3	23.4	+2.4	24.2	+2.5
55	16.7	—0.8	16.6	+1.4	17.1	+1.4
65	11.3	—0.7	11.3	+0.8	11.7	+1.1
Female						
0	42.9	+2.3	45.6	+4.7	54.0	+3.2
5	53.1	+2.1	56.7	+6.5	59.0	+3.8
15	47.6	+2.3	49.9	+6.5	52.3	+5.0
25	40.7	+2.5	42.0	+5.2	44.2	+4.9
35	33.3	+1.7	34.3	+3.9	36.2	+4.4
45	25.9	+1.1	26.7	+3.2	28.2	+3.7
55	18.9	+0.9	19.5	+3.3	20.7	+2.9
65	13.1	+0.8	13.1	+2.7	13.8	+1.9

[1] As this cohort was only 50 years old in 1950, life expectancy for ages above 50 years was computed from 1950 death rates for persons 50 years of age and over. Our data show relatively little change has occurred in these rates in the past 70 years. However, it is more than possible that advances in medical science during the next 30 years will substantially change these rates downward and the cohort will outlive its life expectancy at birth by many more years than are shown here when it reaches its extreme life span about the year 2000. The same, but to a lesser degree, is true of the 1880 and 1890 cohorts.

SUMMARY

In summary, the analysis of both types of life tables clearly points to the progress made in medical science and health care during the past 70 years. An increase of 27 years for males and 30 years for females in life expectancy has not only been an effect but has been a

cause of marked social change. When a "real" cohort of persons was traced through its collective lifetime it was seen that life expectancy at birth was an underestimate of the "real" average length of life of the groups. The cohorts of 1910, 1920, etc. are still too young to permit construction of a generation life table, but it is probable that they will exceed their life expectancy at birth by many years.

It is also probable that medical advances still to come, and their application to all persons in the population, will result in continually increasing life expectancy and that succeeding cohorts of babies will actually outlive their life expectancy at birth. By the time age specific mortality rates become so low that they are practically irreducible, science will be progressing on the problem of increasing the extreme life span.

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THE DISTRIBUTION PATTERN OF DENTAL CARIES

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IN collecting data on the epidemiology of dental caries various designations like D. M. F., *i. e.*, decayed, missing and filled (Klein *et al.*, '38 and '40, and Boyd, '43), and C. R. L., *i. e.*, carious, restored and lost (Barr, '49) have been used for both teeth and tooth surfaces. These indices are not always appropriate and sometimes may lead to confusion. At the time of examination two or more coalesced carious lesions may *appear* to involve two or more surfaces of a tooth and this destruction may, in reality, represent a one-surface lesion which has been left untreated and which has progressed so as to involve other tooth surfaces. Missing teeth may have a variety of reasons for their status. Many compound fillings do not indicate precisely which surface or surfaces were involved originally by the process of tooth necrosis. In addition to the foregoing, some operators place fillings in teeth which may not be defective at the time of operation, just to prevent them from becoming carious in the future.

Bodecker ('31) suggested that completely destroyed crowns of teeth, with only roots remaining, should count 5 points in the score of affected surfaces and lost teeth three points. Hollander and Dunning ('39) assumed in their study that each missing tooth represented three lesions. Klein and Palmer ('40) stated that if a one-surface involvement affects the pulp and necessitates extraction of a tooth, such severity could be considered as a 5-surface involvement by caries.

The author agrees with Wessels and Cheyne ('47) that while it is true that 5 surfaces of a tooth may be lost with the extraction of the

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tooth, this arbitrary consideration does not give information on the exact statistical status at the time of, or prior to the time of extraction. The reasoning of the investigators discussed earlier does not take into account the true biologic characteristics of dental caries. After considering the distortions which can be produced in the statistical results obtained by relying on the above-mentioned imperious assumption, it seemed desirable to conduct a statistical analysis of clinical data which did not necessitate the inclusion of any hypothetical material.

PRESENT STUDY

Material

The present report deals with the patterns of proximal carious lesions in the permanent teeth of 140 white females between the ages of 18 and 21 years. All European ethnic strains commonly found in the United States were encountered in the group which, as a whole, represented the middle class population both socially and economically. All individuals examined were studying to become dental hygienists.

Method of Examination

A complete clinical examination of each dentition was carried out by the author, utilizing artificial illumination, a sharp probe and a mouth mirror. The examination and recording of findings were done with extreme care, taking about 15-20 minutes in each case. A complete set of both intraoral and bitewing X-rays was taken and the clinical recordings were carefully verified by comparing them with the radiographic findings. Each filling was taken to represent a carious lesion. Dental casts were available for each individual and they were analyzed for crowding and spacing of teeth and other characteristics of occlusion.

ANALYSIS OF DATA

For purposes of analysis only the mesial and distal surfaces were considered. Other surfaces were not included in the analysis, in view of the fact that prophylactic odontotomy is practiced by some dentists, so that in treating a proximal lesion the occlusal surface may also become involved. It was realized, also, that frequently it is necessary to extend a proximal cavity preparation to a non-proximal surface in order to secure access to the lesion and to obtain better mechanical anchorage for the filling. Third molars were not considered in this investigation since they were not clinically present in all the individuals

studied, either because they were unemerged, or because they were absent due to agenesis (Nanda, '54) or early extraction.

All records of individuals with extraction of one or more teeth of the second dentition, or with teeth supporting jacket crowns, fixed bridges or partial dentures, were eliminated from the group before analysis.

A considerable number of young women with either natural spacing or crowding of the teeth was seen. As the relationship of spacing and crowding of the teeth to dental caries is still disputed, these subjects also had to be excluded from the analysis. Individuals who were completely free of dental caries were left out also, since they furnished no data of value in this type of research.

After the elimination of all of the above-described types of unsatisfactory basic clinical data, the remaining records were arranged in a serial order on the basis of an increasing total number of proximal lesions. The material pertaining to the maxillary and mandibular teeth was arranged separately. Eighty records of maxillary and 68 records of mandibular dentitions were available for detailed study. The number of records on maxillary and mandibular dentitions could not be kept equal. In order to obtain the maximum quantity of data for analysis, the data on the maxillary and mandibular dentitions were not taken necessarily from the records of the same individuals in all cases. It was assumed that the procedure followed would not cause any appreciable distortion in the findings.

FINDINGS

Bilateral Symmetry of Carious Lesions

Review of Literature. Leigh ('23) noticed the occurrence of dental caries to be bilaterally symmetrical, when groups of individuals were considered. Knutson and Klein ('38), Brekhus ('28), Cheyne and Drain ('40) noted a high degree of similarity between tooth mortality figures for the two sides of the oral cavity. Leigh ('41, p. 157) reported on the bilateral symmetry in the pattern of dental caries. Strusser and Dwyer ('41, p. 214), Hyatt ('41, p. 132) and Scott ('44) have pointed out that the phenomenon of bilaterality was found repeatedly in the material studied by them. Losee ('47) reported that the carious tooth surfaces occurred both in the abutting and bilaterally symmetrical pairs with greater frequency than if their distribution were determined by chance alone.

The results reported by the above-mentioned observers are based on the comparison of the total number of carious lesions in various morphologic groups of teeth. Study of data in this manner does not indicate the extent of bilaterality seen at the individual level. It is not clear, from the reports just discussed, with what degree of reliability the presence of a lesion in a particular surface of a given tooth can be predicted by examining its antimere.

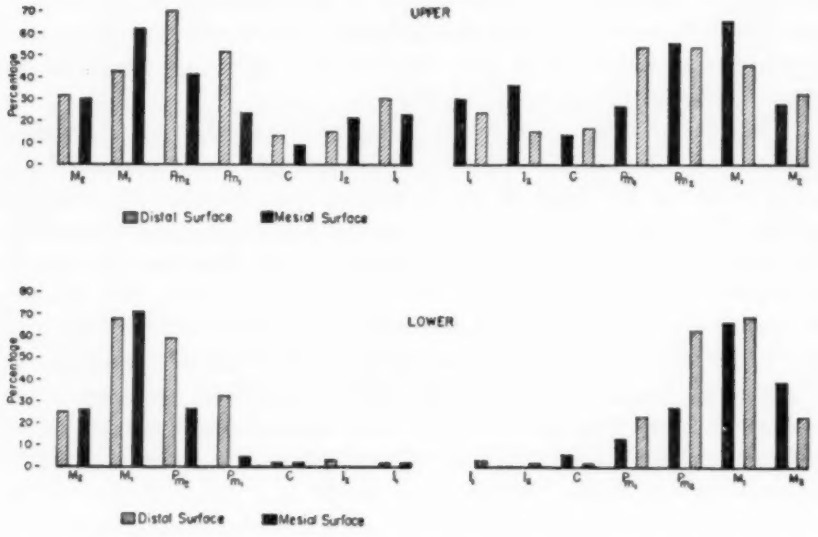

FIG. 1. The regional distribution of the caries in the proximal surfaces of permanent teeth, studied collectively in 80 maxillary and 68 mandibular dentitions. Each bar shows the percentage of carious surfaces in the sample. The chart has been arranged so that the right side of the mouth is represented on the left side of the chart and vice versa.

Barr ('49), from his study of over 500 individuals, reported a marked association between the occurrences of proximal surface caries in the teeth of the right and the left sides, studied collectively, but this high degree of bilateral symmetry was seldom encountered in individual cases.

The data were studied both collectively and individually. Figure 1 shows the "geographic" distribution of these lesions and also the collective degrees of bilaterality which exist in the group of individuals examined. The distribution and the bilaterality of the carious defects

found in the proximal surfaces of the teeth examined are given in tables 1 and 2.

To determine whether the many instances of bilaterally occurring lesions in the corresponding proximal surfaces of antimeres could be due to chance, the Chi-square test[1] (with Sheppard's correction) was applied. As would be expected with the limited quantity of data at hand, the Chi-square values obtained differ considerably for the different morphologic classes of teeth (see tables 1 and 2). They could not be computed at all for the mandibular incisors and canines, as the number of carious surfaces observed in these teeth was too small for the purpose.

TABLE 1

Bilaterality of Caries in the Proximal Surfaces of 80 Maxillary Tooth Pairs

TOOTH	SURFACE	CARIES ABSENT ON BOTH SIDES	CARIES PRESENT ON LEFT SIDE ONLY	CARIES PRESENT ON RIGHT SIDE ONLY	CARIES PRESENT ON BOTH SIDES	χ^2	P
I_1	m	52	6	4	18	35.47	<.01
	d	48	8	13	11	7.57	<.01
I_2	m	47	12	4	17	22.14	<.01
	d	62	6	6	6	10.52	<.01
C	m	66	7	3	4	7.87	<.01
	d	62	7	5	6	10.55	<.01
Pm_1	m	47	14	12	7	0.80	N.S.*
	d	24	15	13	28	6.08	<.01
Pm_2	m	23	24	12	21	0.78	N.S.*
	d	16	8	21	35	4.63	.03
M_1	m	17	14	10	39	8.61	<.01
	d	29	17	14	20	2.49	N.S.**
M_2	m	45	11	13	11	2.23	N.S.**
	d	46	9	8	17	18.58	<.01

* Not significant between limits of .30 and .50.
** Not significant between limits of .10 and .20.

It is clear, also, on mathematical grounds that will not be discussed in this paper that the Chi-square test is of increasingly more limited use-

[1] For the method of computation of the Chi-square values, the reader is referred to any of the numerous standard texts on statistics.

fulness the more the proportion of carious surfaces departs from 50% of the total number of the tooth surfaces under consideration. This means, in practice, that many of the Chi-squares obtained for molars and premolars should be interpreted with caution, and that the P values for these teeth should not be taken at full face value.

TABLE 2

Bilaterality of Caries in the Proximal Surfaces of 68 Mandibular Tooth Pairs

TOOTH	SURFACE	CARIES ABSENT ON BOTH SIDES	CARIES PRESENT ON LEFT SIDE ONLY	CARIES PRESENT ON RIGHT SIDE ONLY	CARIES PRESENT ON BOTH SIDES	χ^2	P
I_1	m	67	0	1	0	—	—
	d	67	0	1	0	—	—
I_2	m	68	0	0	0	—	—
	d	66	0	1	1	—	—
C	m	64	3	0	1	—	—
	d	67	0	0	1	—	—
Pm_1	m	56	9	3	0	—	—
	d	37	9	15	7	0.63	N.S.*
Pm_2	m	42	8	7	11	11.37	<.01
	d	21	7	6	34	22.10	<.01
M_1	m	12	8	10	38	8.00	<.01
	d	11	11	10	36	4.30	.03
M_2	m	35	15	6	12	4.20	.04
	d	48	3	4	13	31.50	<.01

χ^2 cannot be computed where one cell is zero.
* Not significant between the limits of .30 and .50.

The reader should not draw the conclusion that it was felt that the Chi-square test, as employed here, gives an exhaustive or complete analytical account of bilateral symmetry in the clinical material studied. About all that can be said regarding P values tabulated in tables 1 and 2 is that, in general, they discredit any arbitrary hypothesis of no connection between the caries proneness of corresponding surfaces of right and left teeth. Probability values of less than 0.01 in particular suggest that the bilateral associations shown by the raw data are not explainable on the basis of pure chance alone.

The Occurrence of Caries in Adjacent Proximal Surfaces of the Teeth

The possible effect of a pathologic process in one proximal surface upon an adjacent proximal surface was also studied from the data available. The results obtained are shown in tables 3 and 4. The Chi-square test could be applied to only some of the data for contacting surfaces, because the total number of the defects in many such surfaces was too small for statistical analysis. Those surfaces for which caries figures were studied showed a high correlation between the occurrence of lesions in adjacent proximal surfaces, though the values of Chi-square varied considerably for different pairs of contacting surfaces. The tables have been presented in full, even for the teeth for which the Chi-squares could not be computed, as the recorded observations may be of interest to other students of the problem.

The data analyzed indicate a definite tendency to development of lesions in contacting proximal surfaces of adjoining teeth. Although no percentage values for distributions are shown in tables 3 and 4, it is evident that, in general, the proportion of lesions in *both* contacting surfaces is equal to, or more than, the proportion of lesions in only one of two such surfaces. This generalization cannot be made for the teeth which have an overwhelming preponderance of sound adjacent proximal surfaces. Moreover, it does not hold for the distal and mesial surfaces of mandibular M_1 and M_2, respectively, which seem to be remarkably dissimilar in their susceptibility to dental disease (see table 4, bottom line).

The data presented in tables 3 and 4 indicate the relative independence of many contacting teeth as regards their susceptibility to similar local environmental agents of tooth destruction and tooth preservation. The few small P values obtained do not rule out the probability of high degrees of constitutional individuality of many neighboring teeth in some dentitions.

The Distribution of Extracted Teeth

In this study care was taken to eliminate from the material analyzed all records that dealt with dentitions with either agenesis of teeth or loss of teeth due to accidents. Also, dentitions with teeth extracted for failure to emerge or for orthodontic reasons were not included. Following the processing of original data in the manner just described, the dental records of 100 individuals were available for the study of distribution pattern of teeth extracted due to caries.

TABLE 3

Occurrence of Caries in Adjacent Proximal Surfaces of 80 Maxillary Tooth Pairs

APPROXIMATING SURFACES				CARIES ABSENT FROM BOTH SURFACES	CARIES PRESENT IN			χ^2	P
TOOTH	SURFACE	SURFACE	TOOTH		FIRST SURFACE ONLY	SECOND SURFACE ONLY	BOTH SURFACES		
I_1	mesial	mesial	I_1	52	4	6	18	34.47	<.01
I_1	distal	mesial	I_2	63	2	7	8	—	—
I_2	distal	mesial	C	75	0	3	2	—	—
C	distal	mesial	Pm_1	73	2	3	2	—	—
Pm_1	distal	mesial	Pm_2	46	9	6	19	24.2	<.01
Pm_2	distal	mesial	M_1	33	11	11	25	14.06	<.01
M_1	distal	mesial	M_2	56	12	4	8	10.6	<.01

TABLE 4

Incidence of Caries in Adjacent Proximal Surfaces of 68 Mandibular Tooth Pairs

APPROXIMATING SURFACES				CARIES ABSENT FROM BOTH SURFACES	CARIES PRESENT IN			χ^2	P
TOOTH	SURFACE	SURFACE	TOOTH		FIRST SURFACE ONLY	SECOND SURFACE ONLY	BOTH SURFACES		
I_1	mesial	mesial	I_1	67	1	0	0	—	—
I_1	distal	mesial	I_2	67	1	0	0	—	—
I_2	distal	mesial	C	65	2	1	0	—	—
C	distal	mesial	Pm_1	64	1	3	0	—	—
Pm_1	distal	mesial	Pm_2	56	1	6	5	—	—
Pm_2	distal	mesial	M_1	21	8	12	27	10.0	<.01
M_1	distal	mesial	M_2	28	27	3	10	2.21	N.S.*

* Not significant between the limits of 0.10 and 0.20.

Excluding the third molars, 160 teeth were found to have been extracted from the afore-mentioned 100 dentitions: 71 of them were maxillary and 89 were mandibular teeth. The distribution of extracted teeth is shown in figure 2. Each bar indicates the percentage of

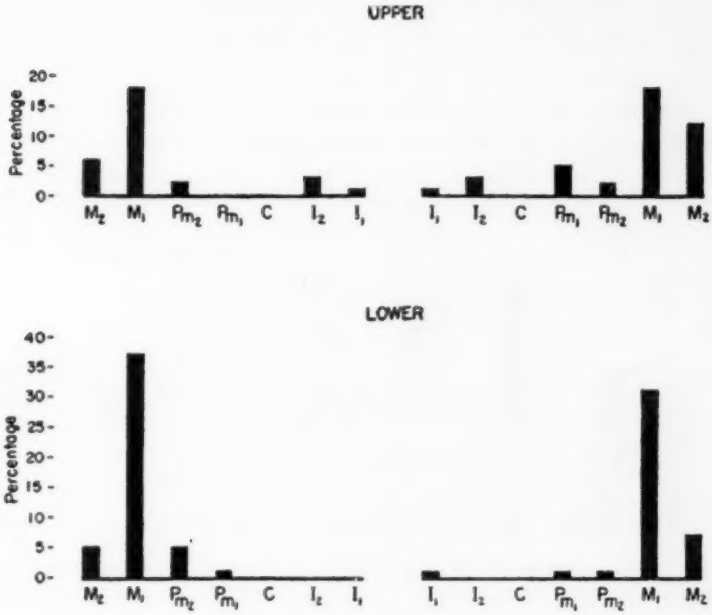

FIG. 2. The regional distribution of teeth extracted due to caries in 100 females. Each bar shows the percentage loss of a particular tooth in the group. The chart has been arranged so that the right side of the mouth is represented on the left side of the chart and vice versa.

extracted teeth in the group under study. The first molars in both jaws accounted for the majority of such teeth. Of the total of 160 extracted teeth, 104 were first molars. The mandibular first molars had the highest frequency of extraction, maxillary first molars were second in rank and the second molars in both jaws the third.

A great deal of bilateral symmetry was again noticed in the pattern of extracted teeth, considered in terms of the total group, but this symmetry was not frequently encountered at the individual level.

• Not significant between the limits of 0.10 and 0.20.

Origin and Spread of Carious Lesions

(1) *Maxillary Teeth.* For the purposes of this study, the individual records for the maxillary and mandibular dentitions were arranged separately, in the order of the aggregate number of lesions in the arches. From the series of 80 maxillary dentitions, the 32 records, which indicated the presence of from one to 7 carious or filled surfaces in all, were singled out. The figures for a given proximal surface of the right and left teeth were arbitrarily added together and a table showing the aggregate number of lesions in the mesial and distal surfaces of each of the 7 teeth, first incisor to the second molar, was obtained. This was done in order to find out which proximal surface of a given

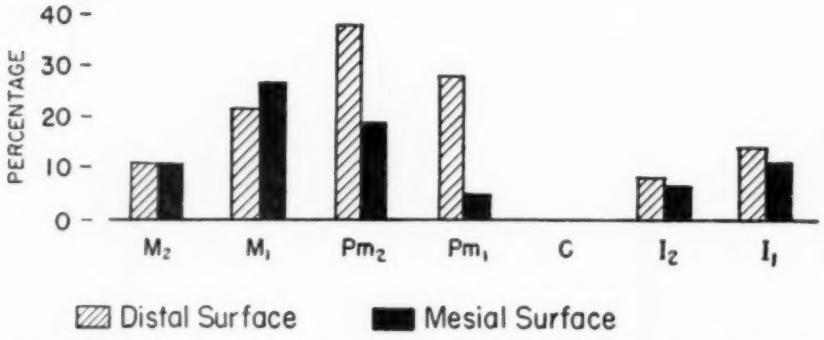

FIG. 3. The percentages of affected mesial and distal surfaces in the maxillary teeth of 32 individuals with a total of one to 7 defective proximal surfaces per individual maxillary arch. The figures for the right and left sides have been added together.

maxillary tooth, considered collectively, is the most susceptible to dental caries or the most likely to be affected first. The proportion of defective proximal surfaces, out of the total of 64 proximal surfaces of a particular kind in this group of 32 maxillary dentitions, is expressed in the form of percentages in figure 3 for each of the two surfaces of each of the 7 classes of teeth. It is clear from this figure that the distal surface of the maxillary second premolar is the most frequently affected among the 32 individuals chosen as having relatively fewest proximal lesions in a total group of 140 young women examined.

To determine further which surfaces are relatively most susceptible to dental caries, the data on the 32 maxillary dentitions mentioned above were divided into subgroups on the basis of different aggregate levels

of proximal surface involvement. This was done to prevent any misinterpretation of results which might be produced by considering the data in larger groups. The calculation of percentages for each subgroup was carried out in the manner utilized for computing the percentages of affected surfaces in the entire group of 32. Figure 4 reveals that the distal surface of the maxillary second premolar is the most frequently affected surface in the group of 8 individuals with only one or two proximal lesions each. This was found to be true at all levels

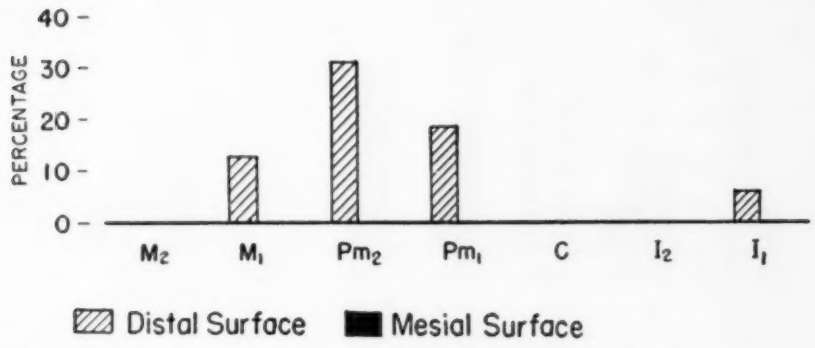

FIG. 4. The percentages of carious proximal surfaces in 8 individuals with 1 or 2 proximal lesions each in the maxillary arch. The distal surface of the maxillary second premolar is most often involved, while no mesial surfaces were defective in this group with the smallest number of proximal lesions.

of proximal surface involvement, as shown in figure 5. Both the mesial and distal surfaces of the canines were seen to be the most immune to dental caries in this group. In general, the distal surfaces, both collectively and individually, showed a higher susceptibility to dental decay than the mesial surfaces of the affected teeth.

From the records on maxillary teeth, arranged in order of increasing number of carious lesions, the 10 individuals with the smallest number of intact proximal surfaces were selected for further study. The number of sound proximal surfaces ranged from one to 10 per maxillary arch in this group. An attempt was made to find out what surface or surfaces were most immune to dental caries in a group which had been selected on the basis of a high susceptibility to the development of proximal lesions.

The data for the right and left sides of the mouth were arbitrarily combined, as in previous analyses. The percentages of sound surfaces,

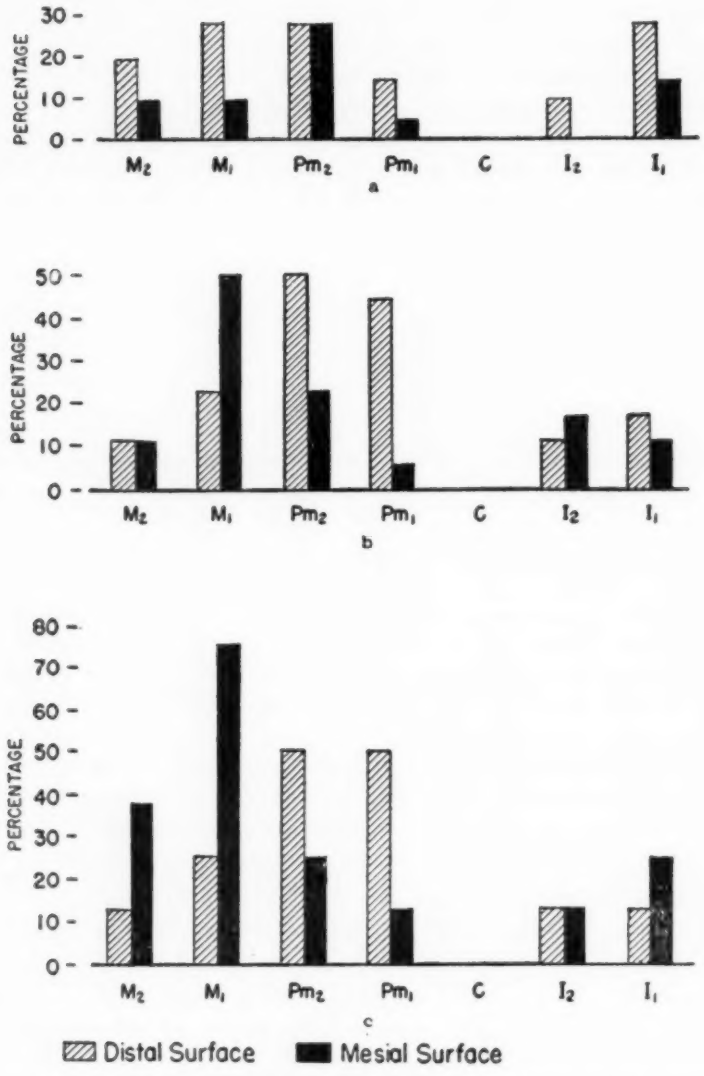

FIG. 5. Percentages of mesial and distal carious surfaces in the maxillary teeth of 24 individuals with different, relatively low degrees of carious involvement.

a. Eleven maxillary arches with three or 4 necrotic proximal surfaces each.
b. Nine maxillary arches with 5 or 6 necrotic proximal surfaces each.
c. Four maxillary arches with 7 necrotic proximal surfaces each.

considered collectively, are shown in figure 6, and for different levels of total involvement in figure 7. It can be seen that, among all the proximal surfaces, the mesial surface of the maxillary first premolar has the greatest immunity to dental caries. Next in rank are the distal surfaces of the central and lateral incisors and next to them the mesial surface of the canine. Even in this group the surface least immune to dental caries is the distal surface of the maxillary second premolar.

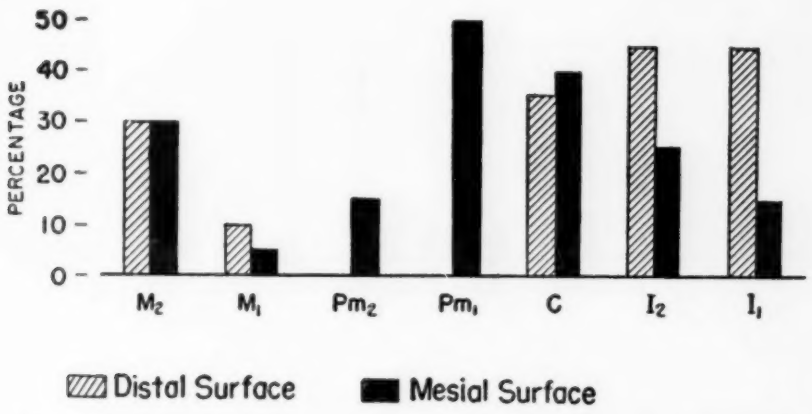

FIG. 6. The percentages of sound mesial and distal surfaces in the maxillary teeth of 10 individuals with one to 10 sound proximal surfaces per individual maxillary arch.

The present data indicate that the distal surface of the maxillary second premolar has the greatest chance to become diseased early and that it is the most caries susceptible surface in the maxillary permanent dentition, while the mesial surface of the first premolar is the most immune to dental caries among all the maxillary proximal surfaces.

(2) *Mandibular Teeth.* The data on the 68 mandibular dentitions, arranged in rank order of increasing number of proximal lesions, were treated in the same way as the data on the maxillary teeth. Twenty-five individuals with one to 5 proximal surface lesions each were considered first. As shown in figures 8 and 9, the mesial surface of the first molar was found to be the most frequently affected proximal surface, while the distal surface of the second premolar was next in order of susceptibilty. Both the mesial and distal surfaces of the first molar

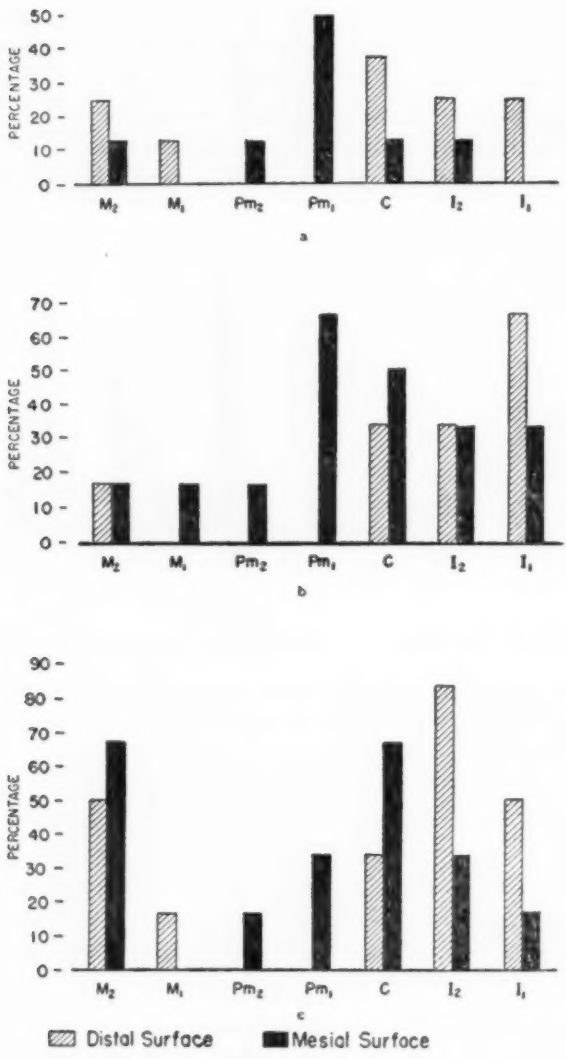

FIG. 7. The percentages of sound maxillary proximal surfaces in three subgroups of the 10 individuals with the highest relative susceptibility to proximal caries.

a. Four maxillary arches with one to 6 sound proximal surfaces each.
b. Three maxillary arches with 7 to 9 sound proximal surfaces each.
c. Three maxillary arches with 10 sound proximal surfaces each.

had the greatest tendency to early involvement at all levels of pathologic spread in the proximal surfaces. The mesial and distal surfaces of the canine, and of the central incisor, and the mesial surface of the second incisor showed the greatest immunity to dental caries in this group.

For the study of surface or surfaces with the greatest immunity to dental caries, in a group of the most susceptible individuals, 13 mandibular dentitions with 12 to 17 sound surfaces each were taken. The

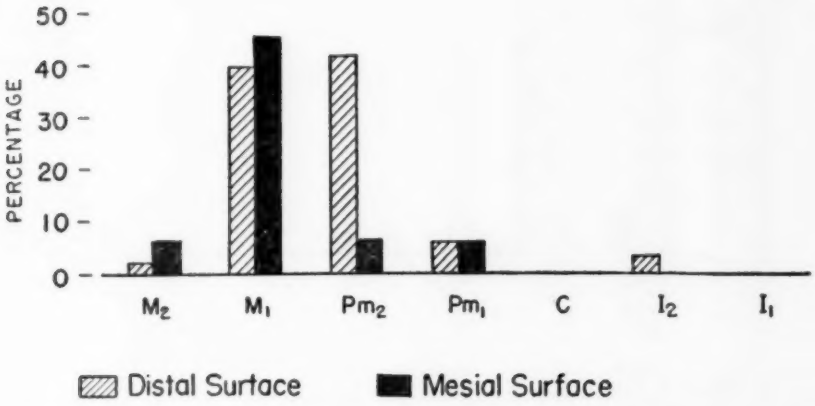

FIG. 8. The percentages of affected mesial and distal surfaces in the mandibular teeth of 25 individuals with a total of one to 5 defective proximal surfaces per individual mandibular arch. The figures for the right and left sides have been added together.

percentages derived are shown collectively in figure 10, and at various levels of spread of caries in figure 11. It is seen that the mesial surfaces of central and lateral incisors had the highest immunity to proximal caries. The least immune surfaces were the distal surface of the second premolar and the mesial surface of the first molar.

The mode of spread of carious lesions is evident from figures 3 and 8. The process of proximal caries involvement seems to start from the mesial surface of the first molar and the distal surface of second premolar. The frequency with which proximal surfaces of other teeth are involved seems to depend primarily on the susceptibility of the individual. The collective distribution pattern of proximal lesions in the different morphologic classes of teeth is shown in figure 1.

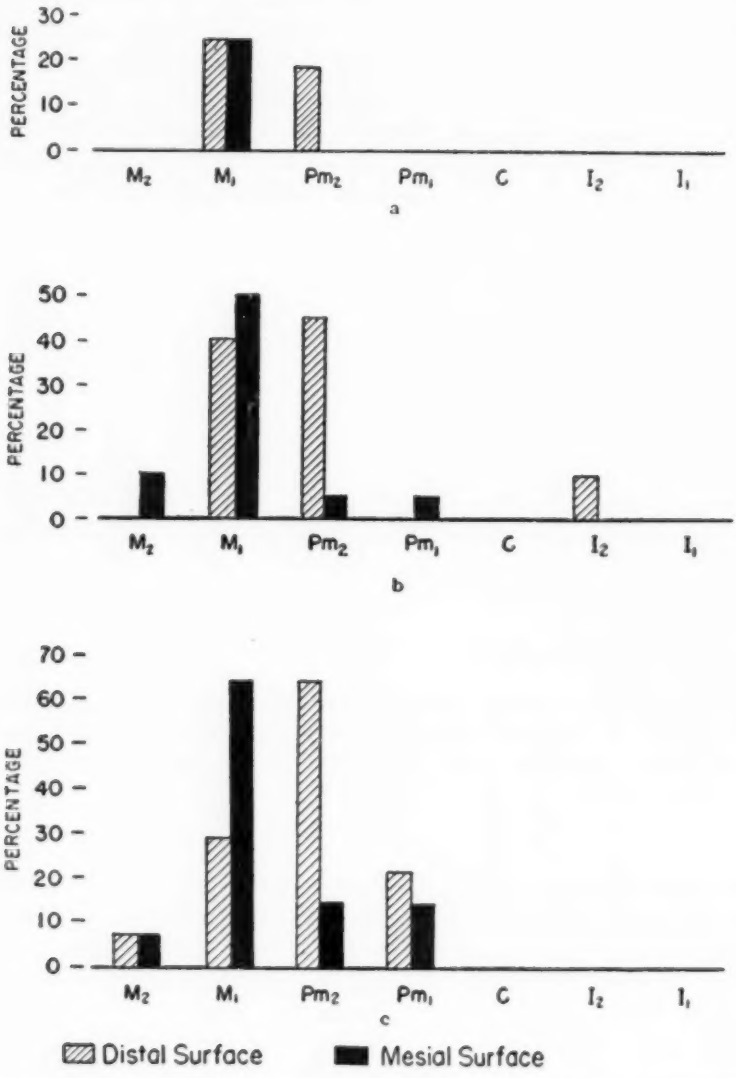

FIG. 9. The spread of carious lesions in the proximal surfaces of the mandibular teeth in three subgroups of the 25 individuals with a low susceptibility to proximal caries. Each bar shows what percentage of a particular proximal surface is affected in a given subgroup.

a. Eight mandibular arches with one or two necrotic proximal surfaces each.
b. Ten mandibular arches with three or 4 necrotic proximal surfaces each.
c. Seven mandibular arches with 5 necrotic proximal surfaces each.

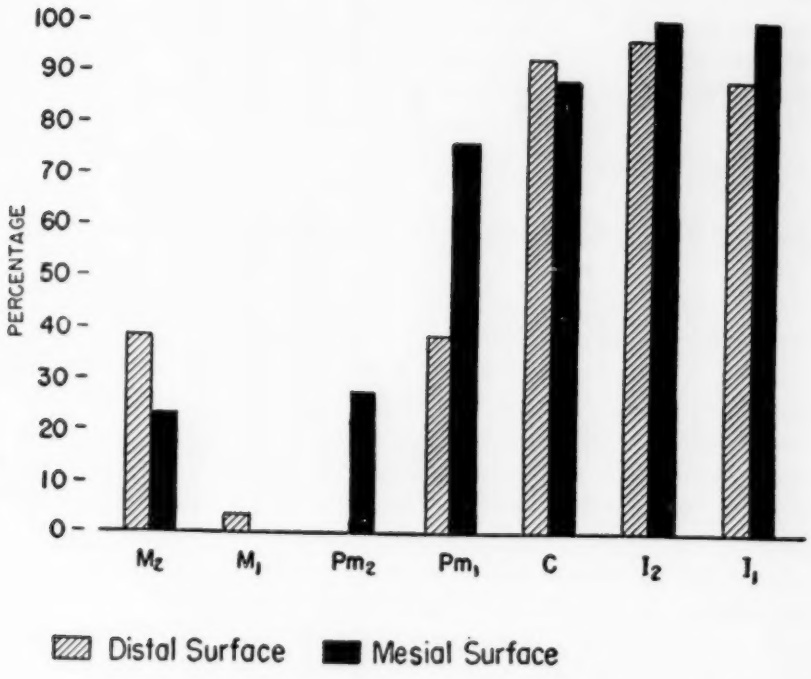

FIG. 10. The percentage distribution of the caries-free proximal surfaces in the mandibular teeth of 13 individuals with a high susceptibility to proximal caries. Each mandibular arch has a total of 12 to 17 sound proximal surfaces.

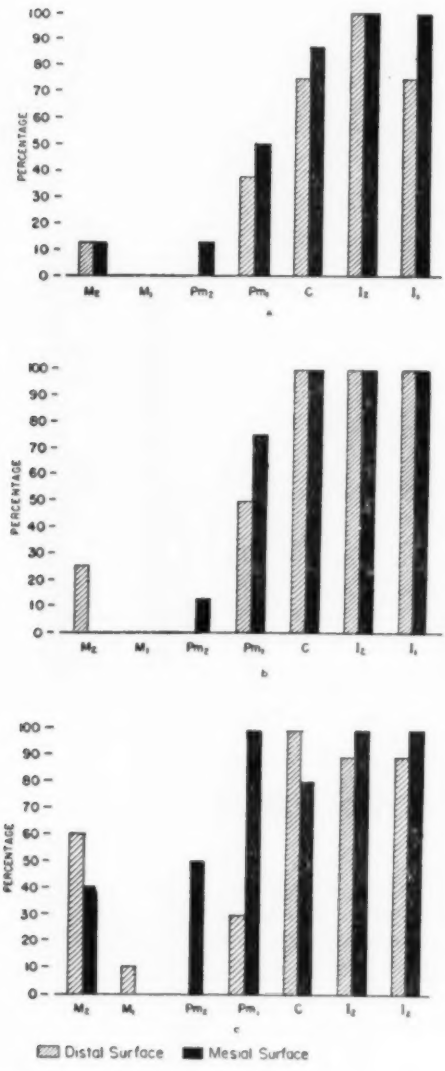

FIG. 11. The percentage distribution of sound proximal surfaces in three subgroups of the 13 individuals with a high susceptibility to proximal caries.

a. Four mandibular arches with 12 to 14 sound proximal surfaces each.
b. Four mandibular arches with 15 or 16 sound surfaces each.
c. Five mandibular arches with 17 sound proximal surfaces each.

SUMMARY

1. The pattern of spread of proximal carious lesions in 140 young, white, American women has been discussed.
2. Statistical tests in both individuals and groups indicate that the occurrence of carious lesions in corresponding proximal surfaces of antimeres—the phenomenon of bilaterality—is not fully explainable on the basis of mere chance and that, likewise, their occurrence in adjacent proximal surfaces cannot be attributed to accident in all instances.
3. The susceptibility of each tooth and each proximal surface varies greatly in different individuals.
4. There is a definite tendency toward a more or less specific regional distribution of lesions.
5. The first molars constitute the bulk of the extracted teeth. Mandibular first molars are more often extracted than maxillary first molars.
6. The usual point of origin of proximal dental caries is the distal surface of a second premolar or the mesial surface of a first molar, in either arch. The subsequent spread of lesions is determined chiefly by the individual susceptibility of each tooth and proximal surface, and usually follows a characteristic tautologous pattern.
7. The last proximal surfaces to succumb are, ordinarily, the mesial surface of the maxillary first premolar and the mesial surfaces of the mandibular central and lateral incisors.
8. No relationship between the length of time a tooth has been in the oral cavity and its susceptibility to dental caries was found.

ACKNOWLEDGMENTS

The author is grateful to Dr. V. O. Hurme for reviewing the manuscript and to Dr. Edward E. Hunt, Jr. for advice in statistical analysis.

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BOOK REVIEWS

Connective Tissue in Health and Disease. Edited by G. Asboe Hansen. 321 pp. Ejnar Munksgaard, Copenhagen, 1954. Dan. kr. 50.

This book represents a thorough resumé of the subject of connective tissue. The information is up-to-date, reviewed by investigators active in the field, and the bibliography includes nearly all of the significant papers dealing with connective tissue.

The list of authors include workers from Denmark, Sweden, Italy, Finland, England and the United States so that a broad viewpoint is presented. The entire subject is thoroughly and interestingly evaluated from the basic sciences dealing with structure, physical characteristics and chemistry, progressing through metabolism and biological behavior to a discussion of the clinical aspects and pathology of connective tissue. The book portrays the dynamic nature of the research that has been focused on connective tissue and the multiplicity of the lines of approach.

The connective tissue is comprised of collagen, reticulin, elastin and ground substance, with their associated fibroblasts, macrophages, mast cells, and minerals. The connective tissue fills the spaces between the cells through which everything going to and much of the material coming from the cells must pass. It transmits the energy of muscular contraction through a reticular sheath surrounding each fiber and thence to fascia, tendon and bone. In the case of the dermis supporting the epidermis, the connective tissue encases the body in a protective covering. The structure is specialized, depending upon function such as the transmission of light by the transparent cornea. Even the vitreous and aqueous humors and synovial fluid are considered to be connective tissue. Not only is it associated with many of the physiological functions of the body, but also it plays a major role in many pathologic processes and participates in repair following injury. With the realization of these facts, it is easy to understand the reason for the complex nature of the subject. Considering the connective tissue field as a whole, it encompasses perhaps every normal and abnormal bodily function, directly or indirectly.

Since the connective tissue in general is metabolically quite inert, it has in the past been neglected as an object of investigation. However, when ACTH and cortisone were shown to relieve so dramatically the symptoms of rheumatoid arthritis, a chronic connective-tissue disease,

the entire thinking in medical practice and scientific investigation changed. For the first time it was widely realized that the inert, unchangeable connective tissue could be altered and that it was a fertile field of medical investigation. Greatly contributing to the aroused interest in the connective tissue were the new techniques being perfected—X-ray diffraction, electron-microscopy, protein chemistry and histochemical techniques. It was inevitable that this broad, unexplored subject with methods of attack at hand and general interest stimulated by the almost miraculous effect of the adrenal cortical hormones would attract an increasing number of investigators.

This book does not attempt to draw conclusions but presents and evaluates the facts in the field of connective tissue as they are now known. Such articles as the Histochemistry of Connective Tissue by J. F. H. McManus, the Chemistry of the Ground Substances of Connective Tissue by Karl Meyer, Hormonal Influences on Connective Tissue by Kurt Iversen and many others should be of interest to the general biologist. The information is presented in a way both refreshing and constructive. No biologist should miss it and the editor should be congratulated.

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Needed Research in Health and Medical Care: A Bio-social Approach. By CECIL G. SHEPS AND EUGENE H. TAYLOR. ix + 216 pp. University of North Carolina Press, Chapel Hill, N. C. 1954. $5.00.

Our understanding and control of disease has gained much in the past by incorporating the skills and knowledge of scientists who have not been initially and primarily concerned with medical or biological problems. The growth and contributions of biochemistry and biophysics are good examples of how fruitful the process of focusing the attention of men trained in other sciences on medical problems can be. This little book is the result of a deliberate attempt, conceived by the senior author, to encourage the social scientist to take an active interest in the problems of medicine. In September, 1952 the Rockefeller Foundation sponsored a conference at Chapel Hill to which were invited representatives of both the medical and the social sciences. The present publication is in effect the authors' personal report of this conference.

The book contains a carefully considered statement on the purpose of "biosocial" research, defines some of the areas that might be fruitfully examined, discusses problems in methodology, and presents certain organizational problems that arise in interdisciplinary work. In addition, there are three pre-seminar statements in the appendix which deserve study.

The material presented provides a good illustration of some of the difficulties of trying to obtain some understanding between scientists whose backgrounds are widely separated. The social scientists who attended the conference appeared to have had some common ground and understanding with the medical administrators and health educators, somewhat less with epidemiologists, and very little with the physiologists and internists interested in the etiology of major chronic diseases. Similar comments could be made about the comprehension of the medical personnel present regarding the tools and productive capacities of the social scientists. It is clear that there must be a good deal of education of both medical and social scientists before effective collaboration at the reasearch level (particularly when problems of the etiology of disease is concerned) can be achieved. Ways and means of obtaining such education are discussed under special organization problems.

This monograph is a "must" for anyone who wishes to work in the area of the relationships between social factors and the disease processes and should be required reading for those who are interested in the knotty problems of multi-disciplinary research.

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Bone: An Introduction to the Physiology of Skeletal Tissue. By FRANKLIN C. MCLEAN AND MARSHALL R. URIST. xii + 182 pp. University of Chicago Press, Chicago. 1955. $6.00.

The interests of the earlier physical anthropologists were mainly antiquarian and descriptive, with a strong emphasis on skulls. At about the point where lengths and breadths of bones and crude statistical seriations failed to yield anything very new or startling, osteometry, like other traditional procedures in gross anatomy, had passed its prime.

It is fortunate indeed that the present century has seen so much

productive work on *ossification*, as opposed to osteometry, so that now a respectable body of knowledge is available on the formation, maintenance and dissolution of the hard tissues. Rather than halting at the surfaces of dead bones, the new bone biologists have continued into the interiors of osseous tissues and treated them as living systems rather than as inert relics.

In the past decade, two syntheses of bone biology have been especially noteworthy: *On Bone and Bones,* by Weinmann and Sicher, and the newer work by McLean and Urist which is reviewed here. The former is the result of collaboration by a pathologist and an atomist, and the latter is by a physiologist and an orthopedist. In comparing the two works, it is surprising how little overlapping of subject-matter can be found. Weinmann and Sicher deal far more extensively with histology, bone diseases, and the growth of specific bones.

On the other hand, McLean and Urist hardly mention specific bones. Instead, they begin with morphology and histogenesis, and continue into a fascinating section on mineralization. The publication of this work is especially timely now, when agreement is rapidly being attained on the relationships between the crystalline lattice of bone and its constituents. Other important topics include the dynamics of calcification, enzyme action, resorption, endocrine agents, metabolism, tissue culture, transplants, the healing of fractures, and diseases of bone. A high proportion of the data came from the authors' own publications in nearly every field discussed in the book.

In some cases the bibliographies of the chapters are too sketchy to support all of the authors' statements. But a few forays outside of these bibliographies convinced this reviewer that the text must have been written with great care, attention to detail, and economy of words.

By virtue of this brevity, McLean and Urist hardly touch upon the morphogenesis of particular bones. A real need exists for an equally modern treatment of this field, but it would be difficult to find a team as good as these two authors to write it.

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Wirksame Faktoren im Leben des Menschen. (Operative Factors in the Life of Man) By OTMAR FRHR. VON VERSCHUER. Weisbaden, Franz Steiner Verlag. 1954. 288 pp. including 105 illust.

A longitudinal study of 159 pairs of twins of the same sex is summarized in this book. The twins were all studied by the author, first in 1924-5, later in 1926-7, 1936, and finally in 1950. For the purposes of this study, 150 pairs are considered (100 identical, 50 non-identical). The average age in 1924-25 was 16 years; in 1950, it was 40 years.

The focus of the discussion is on the relative changes which had occurred over the years rather than on the similarity or dissimilarity of the twins themselves. Of the 150 pairs, 18 had died by 1950; of 34 pairs, one of the pair had died. A high percentage (22%) of males were dead, largely because of World War II. Excluding those killed during the war, the author finds no corroboration of the folk-belief that when one twin dies, the other must follow him into the grave very soon. No regularity or significant difference between identical and non-identical twins is discernible, and all survivors lived a number of years after the death of the other twin.

Consideration of the causes of death (apart from war, of course), reveals that there is no correlation for either kind of twins. The ratio of likeness and unlikeness of cause of death is 9:69 for identical twins, and 4:32 for non-identical. This leads the author to conclude that it is impossible to separate out the hereditary and the environmental factors in disease, and impossible to predict the cause of death. Perhaps we should note that any sub-groups according to disease, such as cancer, heart disease, tuberculosis, and the like, are extremely small.

An interesting finding is the significant number of female twins, one of which is childless. Our author suggests that this might indicate disturbances in the development of the female sexual organs of the pair during pre-natal life.

There is extreme constancy in the bodily development of the twins, over the years. Far and away the most changeable measurement is body weight; then, in order, chest circumference, biacromial diameter, stature. In these latter, and indeed in all skeletal measurements, if the twins were orignally different, they keep about the same order of difference when older. The author emphasizes the constancy of the original body-type. As the subjects were, on the average, post-pubertal when first investigated, his results are not surprising. It is, however, unfortunate,

that he does not evaluate them according to any available constitutional norms.

In the psychic area, great constancy is also manifested. One exception seems to be the emotional tone (*Stimmungslage*); changes are caused by purely environmental occurrences. The author admits that the psychic categories are not as well defined as the physical aspects. Nevertheless he maintains that psychic constancy is quite as marked as the physical.

A number of illustrations of the twins, predominantly of their heads, are presented. There is a complete table of the absolute measurements of the subjects, together with their ages, eye color and hair color. This reviewer would have appreciated a few indices as well.

In general, this book is strongly on the side of heredity rather than environment, except for physical diseases.

J. Franklin Ewing, S. J.

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The Distribution of the Human Blood Groups. By A. E. Mourant. xvii + 438 pp. Charles C. Thomas, Springfield, Ill. 1954. $8.75.

More than one student of human biology has had cause to remark that the increase in the quantity and complexity of our knowledge concerning human blood groups has become so great that to keep up with it has become a full-time job. Thanks to the labors of Dr. Mourant this is no longer so, for in one authoritative, comprehensive, and readable volume he has made available all that the reader is likely to want to know concerning the distribution of the human blood groups.

In addition to the blood groups the author discusses such genetical characters of anthropological value as eye and hair color, PTC, thalassaemia, the sickle-cell trait, color-blindness, and the ability to smell hydrocyanic acid. A fair number of other traits—for example, internal canthic hairs, the palmaris longus muscle (the palmaris brevis is also of great genetic value), tongue furling, and tongue rolling—are not considered.

In separate chapters the author takes up the distribution of the blood groups among the peoples of the world, migrant and hybrid populations, and the blood groups of animals and their relation to those

of man. There are excellent chapters on the blood grouping of bone and tissue specimens, the collection, preservation and transport of samples for blood grouping, and methods of gene frequency calculations for all the blood groups. A chapter devoted to recent discoveries deals with the new antigens. In a most useful chapter entitled "An attempt at synthesis" Dr. Mourant brings together what he regards as the most significant facts, and tries to show how they may be related to one another; he also helpfully speculates on how the blood groups may have arisen and by what stages they may have reached their present complex distribution.

There is an admirable bibliography of 1716 references, 9 maps showing the distribution of the blood groups throughout the world, 40 invaluable blood group frequency tables, a topological index to the bibliography, a zoological index to the bibliography, and a general index.

Reading this volume makes it clear that from being among the poorest genetically known animals man has, in the course of a few years, become one of the genetically best known; the "best," however, is here poor enough, for there remains a tremendous amount of rewarding work yet to be done. Meanwhile we owe a debt of deep gratitude to Dr. Mourant for this stimulating and helpful volume, a volume which is likely to remain the standard work on the subject for many years to come.

M. F. Ashley Montagu

Princeton, N. J.

Human Development. By John P. Zubek and Patricia Anne Solberg. vii + 476 pp. McGraw-Hill Book Co., New York. 1954. $6.00.

The authors describe the book as "a survey of the extensive physical and psychological changes that occur through the course of life from conception through birth, adolescence and maturity to old age." This description in the introduction, like the statement in the preface that "the general orientation is physiological," is quite justified. For both casual perusal and careful reading reveal *Human Development* to be exactly as advertised. Take three parts psychological development, one part physical development, indicate wherever possible what is known about the genetics of behavior and hormone-behavior relationships, and the results will approximate the substance of this work.

Because this is a textbook, intended for students in child development or human development (wherever such a course is taught), its suitability as a text merits consideration. The book is well written. The many subsections are clearly set off by bold-faced captions, so that the student knows what he is reading about. The graphs and charts (and there are over 100 of them) are not only well chosen but for the most part carefully redrawn for maximum intelligibility. Brief summaries of the works cited or key quotations are given, thus avoiding the dangling citation so commonly found in elementary texts. And the 30 pages of references constitute an excellent working bibliography for advanced students desiring further knowledge of human development.

The first hundred pages on neural, glandular and physical development summarize a very broad range of findings, and include examples of the more commonly used measures of growth and development. Here, however, the authors' commendable desire to make the information interesting, occasionally leads them into the pitfalls of the popularizers. For example, in discussing the postnatal growth of the nose, they announce that "it . . . matures earlier than other body parts, thus temporarily distorting facial proportions" (p. 111). On the next page they nearly repeat in toto the familiar misconception that the child cannot walk until his bones have become calcified! Bone growth further troubles them as on page 119 where the number of ossification centers and the number of bones are confused. Minor errors, such as attributing the *somatotype* to Kretschmer (p. 117) and listing Krogman as a pioneer in the use of x-rays on *animals* (p. 120) are of less serious consequence. But sections on bone weight, muscle composition and muscle strength show that Zubek and Solberg have tried hard to assemble a complete account of physical development.

The final chapter on personality development may seem inadequate to many of us. Culture and personality, for example, are reviewed in only 11 lines, including the bare admission that "many personality traits may be culturally determined" (p. 410). The influence of parents similarly is dismissed in a short and uninformative paragraph (p. 409). Toilet-training, breast-feeding, swaddling, authoritarianism, parental indulgence, overprotection—all of these topics are conspicuous by their absence.

Yet these omissions are consistent with the whole plan of the book. For Zubek and Solberg rely heavily on experimental studies and on carefully conceived and adequately reported research. Much of the

published information on the determinants of personality, it must be admitted, fails to come up to these standards. Furthermore, throughout *Human Development* the stress is on the genetic, endocrine, and morphological aspects of development so that the authors need not be censured for their intentional disemphasis on the cultural and situational determinants of the individual personality.

Without question *Human Development* is a commendable and useful elementary text. It should prove valuable to the teacher as well as the student since it affords the psychologist a rapid review of human biology and the biologist an acquaintance with a substantial section of human psychology.

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The Functional Body Measurements of School Age Children. By W. EDGAR MARTIN. vi + 90 pp. National School Service Institute, Chicago. 1954. $1.00.

During most of the history of our industrial civilization, little scientific effort was made to produce goods or equipment in conformity with the physical dimensions of the human body. More recently, the fields of design and anthropometry have begun to interdigitate. Since a majority of professional anthropometrists occupy academic rather than industrial or governmental positions, the initiation of this fruitful alliance has come largely from non-anthropologists.

Since the onset of World War II, the dire necessity of fitting airmen effectively into cramped battle stations in aircraft and human faces snugly into gas or oxygen masks, has brought anthropometrists actively into military research. Projects such as the design of prosthetic appliances, clothing, shoes, or work spaces in vehicles are now the active concern of several physical anthropologists. These specialists can be found in a number of military installations, particularly the Quartermaster Research and Development Laboratories, Natick, Mass., the Army Chemical Center at Edgewood, Maryland, and the Wright-Patterson Air Force Base, Dayton, Ohio. Comparable work has been done abroad on a more limited scale.

In civil life, it is also apparent that seating and work spaces in many instances do not fit the American adult. A pioneer attempt to improve

this situation was the anthropometric survey of seating, published in 1945 by the late Professor E. A. Hooton of Harvard University. This project was initiated by the Heywood-Wakefield Company of Gardner, Mass., in an effort to improve its products. This manufacturer has subsequently produced some excellent new seats by using Professor Hooton's data. More recently, a team at the Harvard School of Public Health, under Professor Ross McFarland, has studied the possible improvement of the dimensions of driver's compartments in American trucks.

One of the difficulties in designing work spaces or seats for American adults is that the mature population of this country is considerably heavier and slightly taller than its nineteenth century predecessors. As a result, antique furniture and the staircases and banisters in old houses are often too low, small or frail by present-day standards.

An even more conspicuous difference in size between Americans today and their ancestors is found in children. At a given age during the school years, an average American child is now considerably nearer his adult size and weight than was a corresponding child in the nineteenth century. This acceleration of growth often makes ordinary school furniture considerably more uncomfortable for a modern child than antique chairs and tables are for modern adults. Such cramping of school children in unsuitable furniture is the problem which stimulated Dr. Martin's study.

This report is based on a set of 55 measurements which were performed on 3,318 school children in southern Michigan in 1954. Some of these dimensions were those used by older anthropometrists, but others were made with the subject seated in an adjustable chair with a desk. Such realistic equipment has been a fundamental part of most modern seating surveys, including those of Professors Hooton and McFarland.

Dr. Martin's report is based on a survey planned and executed by the Laboratory of Physical Anthropoology of the University of Michigan, under the supervision of Professor Frederick P. Thieme. It was subsidized by the National School Service Institute, 27 East Monroe Street, Chicago. This group is an association of manufacturers of school furniture and supplies, and we can therefore expect them to make good use of the data.

The findings are presented in a simple and practical manner: some seriations are divided in accordance with grades in primary school, and others by chronological age from 5 years to maturity. All measure-

ments are not only described fully in the text, but are illustrated above each statistical table on simple mannikin figures.

This report is a very valuable reference work, and can be understood easily by designers and other non-anthropologists. Among possible applications of the data which Dr. Martin mentions is the design of desks, laboratory and shop benches, and bookshelves. Some of the findings might also be applied to children's vehicles and dental chairs. We cannot be certain, however, whether future generations of American children will outgrow these specifications and have to be measured again.

In the meanwhile, here is a project whose execution shows a high standard of professional excellence. Both the text and the tables have been prepared with the clear intent of making the report widely useful. It should be in the hands of every manufacturer of children's vehicles and equipment. A copy is in my work space, and this report deserves to be easily accessible to every professional physical anthropologist.

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The Fossil Evidence for Human Evolution: An Introduction to the Study of Paleoanthropology. By W. E. LE GROS CLARK. x + 181 pp. University of Chicago Press, Chicago. 1954. $6.00.

If you were to discover a new fossil man, one of the first persons whose opinion you would seek would be W. E. Le Gros Clark, professor of anatomy at Oxford. He has studied, described and discussed many important skeletal remains, notably those of Proconsul and the Australopithecinae from Africa. The search for an author of a small book synthesizing what is known of fossil man for an audience of well-informed biologists (the purpose of the Scientist's Library series in biology and medicine, of which this work is the second title) virtually narrows to Le Gros Clark alone. Few, if any, others share his experience in the study of primate fossils, knowledge of biological principles, and mastery of methods.

If the reader knows enough of the subject to grasp the meaning, he will appreciate the terse descriptions, the wealth of pertinent details, the information about important discoveries of the last few years and the lucid statements of the author's own views on many of the still unsettled problems of interpretation.

Le Gros Clark applies principles of general evolution to his interpretation of human fossils. He mentions the possible roles of natural selection, mixture, random genetic drift and mutation. For instance, he says: "While the principle of irreversibility of evolution is perfectly sound in its general application, it is not legitimate to use it as an argument against ancestral relationships in reference to isolated characters which may have quite a simple basis and which are not obviously related to any marked degree of *functional* specialization. It is well known that some mutational processes may be reversible, for this has actually been demonstrated by genetic studies in the laboratory."

The dual approach to understanding human evolution through study of the fossils and analysis of the process is sound. But it is not quite achieved. It still remains for someone to write a self-sufficient text for the beginning student. Le Gros Clark gives much space to the definition of the scientific Latin names used in paleoanthropology. Whatever he gains in precision thereby is offset by two disadvantages: one, those previously unfamiliar with the terminology will find it difficult to follow the argument; and two, the emphasis on the formal taxonomy focuses attention on types and stages in such a way that the reader, despite the occasional mention of selective adaptation and genetics, easily loses sight of the *course* of human evolution.

One example may illustrate the problem. Together with most other students of fossil man, Le Gros Clark believes that modern man is less closely related to Western European Neanderthal man than to men known from remains of earlier pre-Würm age. However, Le Gros Clark alters the usual emphasis. He says: "On the basis of the morphological and chronological evidence at present available, the most reasonable (but still quite provisional) interpretation is that a primitive type of *H. sapiens* came into existence by the Middle Pleistocene, presumably from an earlier small-brained type represented by the *Pithecanthropus* stage of hominid evolution; that *H. neanderthalensis* arose as an aberrant (and, in some respects, a retrogressive) collateral line from pre-Mousterian or early Mousterian *H. sapiens*; and that the former species eventually became extinct."

In order to defend this taxonomy, in which he derives an extinct species from the surviving one, Le Gros Clark is obliged to define *H. neanderthalensis* narrowly and to emphasize certain features of the cranial base and the post-cranial skeleton which are preserved in only a few of the specimens. And since the creation of a third category would be

of dubious value, he must then include within the species *H. sapiens* a wide range of variants including the specimens from Steinheim, Fontéchevade, Swanscombe, Ehringsdorf, Quinzano, Krapina, Saccopastore and Mount Carmel (in part). Some of these are Neanderthaloid in respect to large brow ridges, thick skulls, extremely taurodont teeth, small mastoid processes, poorly developed chins and some degree of platycephaly. One wonders why Le Gros Clark retains, and uses so much space to redefine, the specific name, *H. neanderthalensis*, for he says: "The recognition of a specific distinction on the basis of a fossil record which is by no means complete must, of course, involve an element of doubt. But the chronological evidence at least indicates rather strongly that *H. neanderthalensis* was a typical divergent radiation *in process of speciation*, even if this process *had not become quite complete in the genetic sense* by the time this group of Paleolithic man became extinct." (Italics are the reviewer's).

For the most part the interpretations now most widely held follow closely those of Le Gros Clark. He groups the fossil finds into a gradational series of types—modern *Homo sapiens*, Early Mouterian and Acheulian man, Pithecanthropus (including Pekin man and "Meganthropus"), Australopithecus, and Pliocene and Miocene anthropoid apes. He views such a series as chronological (with the possible exception of overlap of Pithecanthropus and Australopithecus) as well as morphological. Hence, although he thinks it unlikely that we have yet found the remains of our very ancestors, he presents this series as one of ancestral human stages.

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Free and Unequal: The Biological Basis of Individual Liberty. By ROGER J. WILLIAMS. xiii + 177 pp. University of Texas Press, Austin, Texas. 1953. $3.50.

Addressed primarily to the lay reader, this book is written in a popular and dramatized style, with no bibliography, footnotes, or any other formal citation of sources. The author presents essentially three points: (1) individuals differ widely; (2) these differences are derived largely from heredity; and (3) human variation should be taken into account in such matters as social and educational planning, group relations, and inter-personal contacts of daily living.

In developing the first point, Dr. Williams refers to individual differences in a wide variety of human characteristics, ranging from fingerprints and the chemical composition of urine to mathematical aptitude and artistic preferences. Well over half of the book is devoted to convincing the reader that people do differ—widely and in all traits. Some attention is likewise given to intra-individual variation and trait patterns. Thus the author reiterates the fact that people cannot be adequately classified in terms of a uni-dimensional measure such as an IQ, but should be compared in separate abilities. All of this is, of course, elementary knowledge to anyone who has taken a beginning course in psychology. It is undoubtedly desirable to present such information in a vivid and popularized manner for lay readers, as this book does. But it is regrettable that the book leaves one with the impression that such findings are new or even revolutionary. Nowhere is the reader told that during more than half a century psychologists have conducted many hundreds of studies on the nature, extent, and causes of individual differences.

The author's principal object in writing this book appears to be a plea for more consideration of individual differences in the practical business of everyday life. This, too, is a positive contribution and provides a number of thought-provoking ideas. The weakest part of the book, however, is the assumption of an hereditary basis for all the reported human differences. Moreover, it is apparent that the author considers this assumption fundamental to his thesis, although there is no reason why it should be so.

The treatment of heredity is confusing, replete with logical fallacies, and lacking in evidence. The confusion is caused by loose use of terms and poorly formulated questions. For example, the author writes, "We must not lose sight of inborn differences" (p. 23). Indeed we must not! Nor must we assume that such inborn differences are hereditary. Throughout the book, the author refers to the "newborn baby" as his symbol for heredity (*cf.*, *e.g.*, pp. 3, 7, 52). Nowhere is the reader given any inkling of the extensive research on the influence of prenatal environmental factors in the etiology of feeblemindedness or other behavioral and structural deviations in both human and infra-human organisms. In fact, the book strongly reenforces the popular error which identifies birth with the beginning of environmental influences.

Another misconception is that unless a characteristic can be attributed to deliberate training, it must be hereditary. Thus we are told that

"there is a wide diversity of tastes which are not simply trained into people (as is often thought) but are based upon inborn differences of a profound and basic nature" (p. 80). Similarly, there is a recurring implication throughout the book that characteristics which are not hereditary can be changed at will at any time in the individual's life (*cf.*, *e. g.*, p. 140). Underlying much of the book is a gratuitous assumption that environmentally produced differences are superficial and impermanent and that they can be ignored for all practical purposes. This reflects a very limited and naive concept of environment, which is quite at variance with that found in modern biology and psychology.

In support of his contention that individual differences in aptitudes are hereditary, the author refers briefly to Thurstone's current research on homozygous and heterozygous twins. In so far as the pattern of aptitudes was more similar in the former, it is concluded that, "Every newborn baby has a distinctive and complex pattern of inborn mental capacities" (p. 52). No account is taken of the greater environmental similarity in the case of homozygous twins, in comparison both to heterozygous twins and to ordinary siblings, a point which has been repeatedly discussed and richly documented in the psychological literature. Similarly, the author cites many instances of the effect of hormone injection upon such behavior as nest-building and "peck order" hierarchy in various species. He does not, however, mention the equally impressive array of data regarding the influence of early experience upon the subsequent behavior of animals.*

Moreover, inherent in the author's reasoning is a confusion between physiological correlates of behavior and hereditary origin. The establishment of correlation between behavioral and physiological characteristics is a useful intermediate step in the study of hereditary factors. But it is by no means a demonstration of hereditary origin. The author advocates further research on physiological correlates of behavioral differences in human subjects (pp. 154-159). He fails to mention that such studies have so far yielded uniformly unpromising results. To be sure, recent developments in the author's own field of biochemistry, as well as in other sciences, may lead to more fruitful results. But we must guard against putting the conclusion before the data, as the author seems to have done. We must wait until future research has demon-

* A recent survey of such data can be found in F. A. Beach and J. Jaynes. 1954. Effects of early experience upon the behavior of animals. *Psychol. Bull.*, *51*: 239-263.

strated physiological correlates of behavioral differences, which in turn are traced to heredity, before we can make the sweeping generalization that all important human differences result from heredity.

In a chapter entitled "Races, People, Individuality," the author very properly calls attention to the wide individual differences found within each racial group and to the fact that no group can be rated as superior or inferior to another in *all* traits. To illustrate the latter point, however, he choses a weak and dubious example. Thus he suggests that Negroes as a group may excel whites in "capacity for personal loyalty and devotion, for emotional warmth, for religion, for music, for laughter and carefreeness" (p. 124). At least some of the traits included in this example fit into a familiar stereotype which is gradually being dislodged as a result of psychological research and social reform. All such trait differences, moreover, the author attributes to hereditary racial differences. He makes no mention of the mass of research which demonstrates the influence of cultural factors upon group differences. Nor does he seem to be aware of the fact that ethnic differences in aptitude patterns have been investigated. He categorically asserts that such groups have been compared only in general "intelligence" (p. 123).

The author's enthusiasm for the importance of "inborn" (hereditary?) individual differences sometimes involves him in queer logical tangles. Thus he writes, "Further, if we conclude that babies differ from each other in inconsequential ways, we are forced to accept another corollary: One baby could be substituted for another without substantial loss, and there is no consequential basis for regarding the life of any one child as distinctly valuable" (p. 11). Surely the fact of human variability is not the only—or even the major—argument against the wholesale slaughter of babies!

Finally, it should be noted that despite the author's predominant emphasis, the hereditary basis of behavioral differences is not, as he maintains, a radically new idea, calling for an "upheaval in basic thinking" (p. 165). On the contrary, it represents a return to an early viewpoint, away from which the behavioral sciences have been moving during the past 70 years, as the concept of environment has become broadened and refined and as pertinent data have been accumulating. It is unfortunate that the positive contributions of this book are so inextricably intertwined with fallacious and unfounded statements as to render its net value questionable.

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Symposium on Fatigue. Edited by W. F. Floyd and A. T. Welford. viii + 196 pp. H. K. Lewis and Co., Ltd., London, 1953. $4.00.

This publication represents the first volume of the Proceedings of the Ergonomics Research Society, a group founded in Great Britain in 1950 for the purpose of studying the relations between man and his work environment from the differing points of view of the anatomist, physiologist, psychologist, industrial physician, and engineer.

Symposium on Fatigue consists of twenty papers on the physiological and psychological aspects of fatigue, delivered before the Society in March, 1952. The lack of a specific definition of fatigue as well as the complexity of the whole concept can be noted throughout much of the report. Although the precise nature of fatigue is still imperfectly understood, its existence on a physiological basis is indisputable, as in the case of heavy muscular work where it can be related to the amount of exertion in terms of the number of calories expended by the human body. In his study of iron foundry workers, Christensen adds further significant criteria based on measurement of oxygen consumption, pulse rate, body temperature and metabolic rate.

Psychological fatigue, on the other hand, is demonstrated by tasks in which no heavy muscular effort is expended but in which fatigue can still be observed. The two factors usually associated with this type of fatigue are 1) a diminishing output and 2) an increasing effort. Sir Frederic Bartlett points out that both of these criteria are fairly rough and are quite susceptible to variation under many different conditions. As alternatives he substitutes the following as more characteristic of psychological fatigue: 1) an increasing irregularity of the successive items of a task, 2) the failure of the operator to take full advantage of all available information to guide him in his task, and 3) subjective symptoms such as pains and irritations. Of primary importance in this psychological approach to fatigue is the behavior of the organism as a whole. However, a deficiency in the knowledge of the specific physiological functioning of the central nervous system limits a fuller understanding of the problem. A further difficulty is that fatigue may often be confused with other phenomena such as boredom which at times produce similar manifestations.

The various approaches and the subject-matter presented in this report are sufficiently diverse to give a good coverage of current research into the meaning and causes of fatigue, psychological as well as physiological. The results of the original studies, as well as the discussions

of previous work, should be of interest to all those concerned with any phase of human biology as well as to those concerned with problems of worker productivity in industry.

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Symposium on Human Factors in Equipment Design. Edited by W. F. Floyd and A. T. Welford. viii + 132 pp. H. K. Lewis and Co., Ltd., London. 1954. $4.00.

The second volume of the Proceedings of the Ergonomics Research Society is concerned with the application of knowledge of human capabilities and limitations, biological and psychological, to the most efficient design of all aspects of equipment and working areas. In this sense it is similar to what is often referred to as "human engineering." The current need for such a biological approach to equipment design is best exemplified by the following excerpts from one of the engineering contributors to the symposium.

"The machines of the engineer are becoming more and more complicated with a corresponding tendency to become more difficult to control. We can no longer afford to leave the human operator to get along as best he can. . . . It is evident that the problems we have to deal with have a strong biological flavor . . . and although our knowledge of the fundamental biological problems involved is far from complete, enough is known to justify the introduction of biological considerations as a distinctive contribution to machine design."

The 15 papers included in the symposium indicate clearly the range and type of contributions that can be made by the various biological and related sciences, varying as they do from recommendations for the design of chairs and tables, or discussions of human responses to design variations in visual displays, to statements of the physiological effects of climate or the circulatory disadvantages of a standing position for certain types of work.

Insofar as each paper presents the specialty of the individual researcher, it may be noted that the volume exhibits a certain lack of cohesiveness. However, the wide scope of the material certainly makes this somewhat unavoidable in such a symposium. This volume is a most worthwhile achievement when considered as a statement of some of the

basic problems in the field, or as a survey of some of the data and of methods currently applied to problems of equipment design. To those unacquainted with human engineering, it can serve as an excellent introduction to some of the aspects of this relatively new field. It demonstrates beyond any doubt the importance of the contributions the biologist can make to the field of equipment design.

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Indian Health in Arizona. By B. S. KRAUS. ix + 164 pp. University of Arizona, Tucson, Arizona. 1954. $2.50.

This publication is based, principally, on a study of records of the Bureau of Indian Affairs hospitals on the Papago, Pima, San Carlos, Colorado River and Fort Apache reservations and the Phoenix Medical Center in Arizona for the fiscal year 1952-53. The Health Branch of the Phoenix Area Office contracted for this work in order to obtain a comprehensive analysis of health conditions and a description of customs of specific tribes which could be used to secure more ready acceptance of modern medicine on the part of Indian patients.

The report acquaints the reader with the location, geography, and population distribution of the Indians on these reservations. It also outlines the organizational pattern of the Bureau of Indian Affairs and the money budgeted for health. A brief but limited discussion of the preventive medicine program is presented. The tabulation on the use of clinic and hospital facilities was done with thoroughness and hence one can gain a reliable picture of the response of the Indian patient to health services. The difference in the validity of hospital records versus the clinic cards should be kept in mind in interpreting the statistics. The outpatient records were often made without adequate diagnostic facilities.

In spite of these limitations, the report should be noted as the first analysis of its kind of morbidity among Indian populations. It makes available much factual information on Indian health and health services in the Southwest, not previously available.

In recent years there has been a marked increase in the interest in "geographic medicine" and in the mode of life, including diet, as a

factor in the development of so called "degenerative" diseases, such as coronary heart disease. The study of well selected groups of American Indians may contribute importantly to the clarification of this large and complex problem.

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BOOK NOTICES

EMOTIONS AND BODILY CHANGES. By Flanders Dunbar. xxii + 1192 pp. Columbia University Press, New York, 1954. $15.00. The fourth edition of a systematic survey of literature (1910-1953) on psychosomatic interrelationships. Orientation and methodology (180 pp.). Organs and organ systems (500 pp.). Therapeutic considerations and conclusions (70 pp.). Bibliography (330 pp.).

A TEXTBOOK OF PHYSIOLOGY. By John F. Fulton. xlii + 1275 pp. W. B. Saunders Co., Philadelphia, 1955. $13.50. Seventeenth edition of W. H. Howell's classical textbook. Nervous activity (240 pp.). Muscle (60 pp.). Sensory functions (200 pp.). Blood (60 pp.). Circulation (240 pp.). Respiration (80 pp.). Body fluids and kidney function (80 pp.). Digestion (70 pp.). Metabolism and nutrition (100 pp.). Endocrines (70 pp.). Reproduction (50 pp.).

THE VERTEBRATE BODY. By Alfred Sherwood Romer. viii + 644 pp. W. B. Saunders Co., Philadelphia, 1955. $7.00. Second edition of an introductory account of vertebrate morphology, with considerations of paleontological background, embryological history, histological structure and physiological function.

FAT METABOLISM: A symposium on the clinical and biochemical aspects of fat utilization in health and disease. Edited by Victor A. Najjar. viii + 185 pp. Johns Hopkins Press, Baltimore, 1954. $4.50. The aim of the symposium was to bring to the attention of the clinical investigator the pertinent new aspects of biochemistry and acquaint the biochemist with the clinical problems. Obesity was examined in reference to the multiplicity of causative factors (Jean Mayer, B. Childs, L. Wilkins) and clinical aspects of obesity in childhood were considered (H. H. Gordon).

THE MERCK INDEX. By Merck and Co., Inc. xiv + 1167 pp. Merck and Co., Inc., Rahway, N. J., 1952. $8.00. Sixth edition of the encyclopedic work on chemicals and drugs. There are 160 pp. of appendices, including different systems of measures and weights, and a table of radioactive

isotopes and their uses in medical diagnosis and therapy. Seventh edition is scheduled for 1960.

STATISTICAL METHODS FOR THE BEHAVIORAL SCIENCES. By Allen L. Edwards. xvii + 542 pp. Rinehart and Co., Inc., New York, 1954. $6.50. Introductory textbook, with special reference to psychology, sociology and education. Aims to make the subject-matter accessible to students with a minimum amount of mathematical training. Incorporates methods of statistical analysis free from the assumption of normality of distribution. Devotes a chapter to significance tests for ranked data.

STUDIES ON THE NUTRITIVE VALUE OF BREAD AND ON THE EFFECT OF VARIATIONS IN THE EXTRACTION RATE OF FLOUR ON THE GROWTH OF UNDERNOURISHED CHILDREN. By E. M. Widdowson and R. A. McCance. viii + 137 pp. (Medical Research Council Special Report Series No. 287). Her Majesty's Stationery Office, London, 1954. $1.90. Children in two orphanages in western Germany were divided into groups and given, in addition to their German rations, as much as they wanted of one of several specially prepared breads made from flours of different extraction rates. Clinical status, biochemical data, radiographs of elbow and wrist, dental caries and tooth structure were used as criteria. Metabolic balances were also carried out. No significant differences in the nutritive value of the different breads could be detected.

ANATOMY OF THE HUMAN BODY. By Henry Gray. 1480 pp. Lea and Febiger, Philadelphia, 1954. $16.00. The appearance of the 26th edition, edited by C. M. Goss, documents the time-tested usefulness of this work concerned primarily with systematic anatomy. A 50 page chapter is devoted to embryology. Surface and topographic anatomy is presented briefly (60 pp.), Quantitative considerations are essentially absent.

STUDIES IN SCHIZOPHRENIA. By Robert G. Heath and 22 co-authors. xiv + 619 pp. Harvard University Press, Cambridge, Mass., 1954. $8.50. A progress report on research on mind-brain relationships, utilizing the techniques and concept of psychiatry, psychology, physiology, biochemistry, neurology, and neurosurgery. Theoretical framework for a multi-disciplinary approach to human behavior (50 pp.). Animal studies (60 pp.). Human studies (260 pp.). Discussions (50 pp.). Focus: Facilitation of cortical activity by electrical stimulation of the septohypothalamic region.

FOURTH ANNUAL REPORT ON STRESS. By Hans Selye and Gunnar Heuser. 749 pp. Acta, Inc., Montreal, 1954. $10.00. An indispensable guide to contemporary literatures on stress. General considerations, including the concept of stress, pathways of responses to stress, development of "adaptation syndrome," interpretation of "diseases of adaptation." Ten articles by guest authors. Systematic index to special physiology and pathology of stress. References (close to 5,000 items). Index of alphabetically arranged cross-references.

THE LANGUAGE OF SOCIAL RESEARCH. Edited by Paul F. Lazarsfeld and Morris Rosenberg. xiii + 590 pp. The Free Press, Glencoe, Ill., 1955. $6.75. A reader in the methodology of social research, it consists of reprints of papers, plus introductory and connecting text, grouped into 6 sections: Concepts and indices, Multivariate analysis, Analysis of change through time, Formal aspects of research on human groups, Empirical analysis of action, Toward a philosophy of the social sciences.

SUICIDE AND HOMICIDE. By Andrew F. Henry and James F. Short, Jr. 214 pp. The Free Press, Glencoe, Ill., 1954. $4.00. An attempt "to bring within a common framework knowledge and theories about the direction of expression of aggression which have developed independently within the disciplines of sociology, psychology and economics." Part I. Relation to business cycle (economic correlates). Part II. Sociological determinants. Part III. Psychological determinants of the choice between suicide and homicide. Appendices.

THE EVOLUTION AND GROWTH OF HUMAN BEHAVIOR. By Norman L. Munn. x + 525 pp. Houghton Mifflin Company, Chicago, 1955. $6.50. A comprehensive textbook bringing up-to-date the author's *Psychological Development* (1938). Coverage: Genetics (40 pp.), Phylogenetic psychology (unlearned behavior, evolution of intelligent behavior, 100 pp.), Ontogenetic psychology (prenatal behavior, sensory processes, motor development, symbolic processes, intelligence, emotional development, social behavior, personality from infancy to senescence, 350 pp.).

HUMAN ENGINEERING GUIDE FOR EQUIPMENT DESIGNERS. By Wesley E. Woodson. 245 pp. University of California Press, Berkeley, 1954. $3.50. To aid engineers by considering the characteristics and limitations of the human operator. The compilation of information was initiated by the Electronics Design and Development Division, Bureau of Ships. Topics: Equipment and work space, Vision, Audition, Body size, Movement, Body sensitivity, Orientation, Bibliography of design applications (16 pp.).

HANDBOOK OF HUMAN ENGINEERING DATA. 2nd edition. By Tufts College, Institute of Applied Experimental Psychology. 400 pp. Tufts College, Medford, Mass., 1952. Aims to "supply information on the practical limits of human performance and sensitivity, beyond which the man, as a control device for machines, begins to break down." Nine parts: Human engineering, Experimental techniques, Body dimensions, Space requirements in aircraft, Vision, Audition, Skin sensitivity and proprioception, Motor performance, Physiological conditions, Intelligence, Learning, and Glossary and Indices.

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